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THE LABILITY OF OCULAR TENSION

A TEST TO DETERMINE INDIVIDUAL VARIATIONS

SYLVAN BLOOMFIELD, M.D., AND ROBERT K. LAMBERT, M.D.

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It has long been appreciated that the maintenance of the ocular tension within a relatively narrow physiologic range is a fundamental necessity for the optimal function of the eye. A deviation of pressure below this norm is followed by morphologic changes in ocular structures that interfere grossly with optic performance. An elevation is attended with progressive pathologic alterations in ocular tissues associated with the syndrome complex of glaucoma.

Basically, the pressure within the globe is determined by the opposing forces of the semirigid wall of the eye and the encompassed structures—solid, semisolid and liquid. It is apparent that while the scleral coat and formed contents of the eye normally remain relatively constant, the circulating intraocular fluids—aqueous, blood and perivascular lymph—are potentially subject to changes in volume that establish them as basic determinants of intraocular pressure levels. Since the amount of lymph present in the eye is small, its effect on tension may be ignored in this discussion.

The volume of aqueous within the globe fundamentally depends on the ratio of its speed of formation and outflow. The precise nature of these processes has been disputed, and no one of the many mechanisms that have been suggested, such as transudation, vitalistic secretion, dialyzation or electrodynamics, has proved completely acceptable. Recently there has been increasing concurrence in the opinion expressed by Friedenwald,[1] that the formation and drainage of the aqueous probably involve many such complex physicochemical processes in dynamic equilibrium. It is apparent, moreover, that in all theories concerning the origin of the aqueous the basic influence of intraocular vascular dynamics must be recognized.

The volume of blood within the eye, as elsewhere in the body, is undoubtedly under the influence of the autonomic nervous system and the interrelated endocrine glands. In addition, intrinsic ocular reflexes may affect the uveal circulation through antidromic impulses along sensory and sympathetic nerves, possibly through the mediation of the uveal perivascular plexuses, the exact function of which is disputed.[2] Chemically, vascular tone is affected not only by the circulating hormones but by local tissue metabolites, typified by histamine.[3] When one considers the vascular capacity of the distensible cavernous tissue of the choroid, the potential role of these automatic agencies in determining ocular tension is more easily appreciated. Thus, Ridley [4] stated that whereas the normal human eye contains 211 cu. mm. of blood, with complete loss of vascular tone, this capacity is increased by 350 cu. mm. The significance of such an augmented volume of blood is emphasized by the fact that an increase of only 150 cu. mm. of blood is sufficient to raise the normal ocular tension to 70 mm. of mercury.

It is obvious, therefore, that the intraocular pressure at any time is dependent on a number of physiologic processes of various degrees of independence. It seems inescapable that their integration and regulation is necessary to maintain the pressure of the globe within a rather narrow normal range. Cannon [5] suggested the term homeostasis to designate those steady states which require complex, coordinated physiologic reactions for their maintenance. He [6] pointed out that in a system composed of unstable structures and subject continuously to disturbance, constancy is in itself evidence that agencies are active or are ready to act to maintain this con-

From the Ophthalmological Service of the Mount Sinai Hospital.

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1. Friedenwald, J., cited by Sugar, S. H.: Evidence for Circulation of Aqueous and Its Relation to Glaucoma, Arch. Ophth. **28**:315 (Aug.) 1942.

2. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1941, vol. 1, p. 417.

3. Duke-Elder,[2] p. 420.

4. Ridley, F., in Ridley, F., and Sorsby, A: Modern Trends in Ophthalmology, London, Butterworth & Co., Ltd., 1940, p. 361.

5. Cannon, W. B., in Piersol, G. M.: Cyclopedia of Medicine, Surgery and Specialties, Philadelphia, F. A. Davis Company, 1939, vol. 7, p. 306.

6. Cannon, W. B., in "A. Charles Richet," Paris, 1926, p. 91.

stancy. It seems reasonable to consider the maintenance of intraocular pressure as a homeostatic system subject to automatic regulatory control for the preservation of the eye at a physiologic optimum.

Elwyn [7] ably indicated the apparent inadequacy of local physical processes for the maintenance of intraocular pressure within a fixed normal range. He suggested that the normal pressure was a phylogenetically evolved optimum the maintenance of which was regulated by some central autonomic agency similar to the mechanisms controlling such vegetative constants as body temperature and blood pressure. As a corollary to this concept, it was suggested that chronic simple glaucoma might be due to an aberration in such regulatory control that manifests itself in elevated intraocular pressure. The local morbid anatomic features classically identified with glaucoma are simply the consequences of this etiologically basic regulatory dysfunction. It is interesting in this connection to note Cannon's [8] observation that while homeostatic levels are not themselves altered appreciably by advancing age, the effectiveness of the physiologic mechanisms that act to preserve stability is reduced. The tendency for essential glaucoma to occur almost exclusively in the older age groups similarly suggests a weakened regulatory control of intraocular pressure with increasing age, though the possible role in the pathogenesis of glaucoma of such local structural changes incidental to aging as enlargement of the lens, sclerosis of the vessels and narrowing of the trabecular spaces also deserves consideration.

If such a regulatory mechanism is active, the development of clinically appreciable ocular hypertension may well be preceded by a more or less gradually increasing instability of intraocular pressure. In other words, an abnormally increased lability of ocular tension should be manifest as the earliest evidence of deficient regulatory control and incipient glaucoma. Pisarello, Kollner, Hagen and others have pointed out the greater variations in the diurnal levels of ocular tension that occur in glaucoma, as compared with the normal curve first described by Maslenikow.[9] This spontaneous evidence of increased lability of tension in the eye remains one of the more reliable signs of early chronic simple glaucoma.

The idea of a test to indicate the increased lability of a homeostatic system as the earliest sign of morbid dysfunction is not new. In cases of diabetes mellitus and of vascular hypertension, for example, evidence of an increased lability in the regulation of levels of the blood sugar and the blood pressure, as indicated by the dextrose tolerance and the cold pressor test respectively, is considered a valuable indication of impending morbidity. The basic idea in such tests is to throw a sudden strain on the homeostatic system by means of a standardized stimulus and to record quantitatively the degree of deviation that occurs and the time necessary for the restoration of the physiologic norm.

The value of such a test for detecting glaucoma in its incipiency is apparent, since the diagnosis is otherwise made largely through evidence of irreversible ocular damage, which might have been prevented with earlier therapy. Appreciation of this fact is indicated by the large number of so-called provocative tests for glaucoma that have been described,[10] quantitatively testifying both to the need for earlier diagnosis of the disease and to the general dissatisfaction, thus far, with the measures devised for that purpose. Most of these procedures have aimed at producing abnormal elevations in the pressure of glaucomatous eyes by augmenting the intraglobal volume either by increasing the quantity of fluid entering the eye or by interfering with the drainage of blood or aqueous. To our knowledge, no such test has proved definitely diagnostic, since the elevations in intraocular pressure produced have been too small or too inconsistently elicited to be of value.

To test effectually the stability of the pressure within the globe requires a stimulus which, when applied to the patient, results in an elevation in ocular tension that is appreciable and is consistently evoked. Since, as previously indicated, the global pressure is largely influenced by the volume of intraocular fluids, the production of a sudden increase in the latter should answer this purpose. Inasmuch as the formation of aqueous and the degree of engorgement of the uveal bed probably are both dependent on intraocular capillary pressure, an increase in the latter produced by interference with the normal vascular circulation in the eye should augment appreciably the amount of fluid within the globe. An increase in inflow of blood and a diminution in drainage had been separately induced by many investigators in various ingenious ways but without the production of consistently satisfactory elevations of ocular pressure. It seemed of interest to us, therefore, to explore the possibility of producing

7. Elwyn, H.: Pathogenesis of Chronic Simple Glaucoma: New Concept of Maintenance of Normal Intraocular Pressure, Arch. Ophth. **19**:986 (June) 1938.

8. Cannon, W. B., in Cowdry, E. V.: Problems of Aging, Baltimore, Williams & Wilkins Company, 1939, p. 624.

9. Duke-Elder,[2] vol. 3, p. 3376.

10. (*a*) Duke-Elder,[2] vol. 3, p. 3389. (*b*) Gradle, H. S.: Am. J. Ophth. **14**:936, 1931; (*c*) in Ridley, F., and Sorsby, A.: Modern Trends in Ophthalmology, London, Butterworth & Co., Ltd., 1940, p. 200.

consistent and appreciable elevations in ocular tension by augmenting the inflow and decreasing the outflow of the vascular supply to the eye simultaneously.

CONTROL STUDIES

In our preliminary control experiments, the subjects were patients of the ophthalmologic clinic and ward service of the Mount Sinai Hospital. The patient was placed comfortably supine on the examining table, and 1 drop of 0.5 per cent tetracaine hydrochloride was instilled in each eye. A sphygmomanometer cuff was applied to one arm and the patient permitted to rest quietly for a short time to insure basal levels of vascular and intraocular pressures. An object for ocular fixation was selected directly above the patient's head to secure a fixed position of the eyes for tonometric readings. Readings of the ocular tension were taken simultaneously with recordings of the blood pressure. This was done at two minute intervals, a few times, before any stimulus was applied to the patient to establish the normal levels. Immediately after the application of the stimulus, readings were taken every minute for three minutes, then every two minutes for twenty minutes and then every five minutes for about a half-hour thereafter. Curves were drawn to record the exact variations in ocular and vascular pressures that occurred during the period of the experiment, before and after the application of the various stimuli that were tested. In this way, the degree of elevations in pressure produced and the time required for the restitution of the original physiologic levels could be quantitatively appreciated and an impression obtained of the lability of ocular tension and its relation to incidental variations in arterial pressure. Such curves are illustrated in figures 1, 2 and 3.

Although this procedure may seem formidable, it is in practice rather simple and quite safe. In over 180 eyes so tested, the only complaint was that of slight corneal abrasions, which occurred in 4 instances and which healed completely within twenty-four hours with a simple pressure dressing. More frequent abrasions were avoided by the careful observation of certain simple precautions that were evolved in the course of the investigation. The amount of tetracaine hydrochloride instilled into the eye was held at a minimum, i. e., about 1 drop of a 0.5 per cent solution every twenty minutes, since excessive use of the anesthetic seemed to cause a slight edema of the corneal epithelium that increased its susceptibility to abrasion. The patient was instructed to gaze fixedly at the chosen point of observation and carefully to avoid ocular movement during the application of the tonometer. Between recordings, blinking was permitted and was encouraged to avoid excessive drying of the conjunctiva and cornea. As far as possible, readings were made with a single application of the tonometer to the eye, in the proper axis to avoid manipulation on the cornea. A quick second reading was occasionally taken to check an uncertain result. During the experiment the integrity of the corneal surface was constantly observed by means of the reflected image of a light source, and fluorescein was occasionally instilled if a defect was suspected. At the first sign of an erosion further experimentation on that eye was stopped.

While any experimental method that utilizes tonometric results is subject to the inaccuracies of that instrument, with proper technic readings so obtained are well within the margin of error of most clinical methods.[11] Furthermore, by using as large a series of cases as possible for statistical evaluation, minor instrumental inaccuracies are rendered less significant. This consideration is necessary since tonometry is the only method available clinically for the measurement of variations in intraocular pressure. Schoenberg [12] pointed out several considerations in the proper use of the instrument that were followed in our experiments. With practice it was found that a single application of the tonometer gave a result that was usually reproducible to one half of a division on the Schiøtz scale in a repeated reading.

Since the repeated application to the eye of a weighted instrument, such as the tonometer, induces a gradual decrease of intraocular pressure due to the massaging effect so induced,[13] a series of control experiments were carried out in which tension curves were drawn by the method described, without the application of any test stimulus to the patient. Thirty-two eyes in 20 patients were so treated. The series consisted of 13 normal eyes, 3 aphakic eyes, 1 eye with secondary glaucoma, 2 eyes with chronic simple glaucoma not operated on, 8 eyes that had undergone various filtering operations for primary glaucoma and 5 eyes with various types of cataract. Abnormally high ocular tensions were present in the eye with secondary glaucoma and in 3 eyes with chronic simple glaucoma, 2 of which were under postoperative observation while the other was untreated. No appreciable difference in the lowering effect on tension of repeated applications of the tonometer was noted with these various conditions except that in eyes with originally lower pressures the decline tended to occur sooner and to somewhat greater degree than in globes with higher pressures. Thus, while the average amount of decrease in tension for the entire series was slightly less than 2 mm. of mercury Schiøtz, that in 8 eyes with an initial tonometric reading of less than 14 mm. was 3 mm. of mercury. These decreases in pressure were gradually progressive, irregular and usually first apparent after eight applications of the tonometer, although the interval varied with different eyes. In only 3 eyes was the depression greater than 3 mm. of mercury, namely, 4 mm. in 2 eyes and 5 mm. in a third eye. All these results apply to the tonometer weighted with the 5.5 mg. block, since this is the one most frequently employed. In 8 eyes measured with the tonometer weighted with the 7.5 mg. block, the average decline in pressure was slightly over 3 mm. of mercury, and this began usually, although variably, after the

11. Duke-Elder,[2] vol. 1, p. 500.

12. Schoenberg, M. J.: Am. J. Ophth. **27**:70, 1944.

13. Duke-Elder,[2] vol. 1, p. 499.

fourth application of the tonometer. In 1 eye measured with this weight there occurred a gradual drop in pressure of 4 mm. of mercury, and in 2 others, a gradual decrease of 5 mm. When the original intraocular pressure was abnormally high, as occurred in the 4 eyes mentioned, the average absolute decrease in tension was the same as that which occurred in the normal pressure group, but the proportional diminution was accordingly much smaller. It must be noted that these results were obtained with a careful technic of single applications of the tonometer, with readings taken as quickly as possible and with minimal manipulation. No appreciable change in systemic blood pressure was noted during these tests. In view of this rather consistent, gradual and relatively slight depressing effect of repeated tonometric tests, it was felt that the massaging effect did not significantly affect the validity of our plan of investigation.

Several methods for inducing an increased flow of blood into the eye were considered. The use of amyl nitrite to induce vasodilation of ocular arterioles was thought inadvisable because of its incidental effects and the difficulty of its administration in uniform dosage. The direct influence of sudden elevations of arterial pressure on intraocular pressure has been clinically observed repeatedly [14] and can be demonstrated experimentally in animals by simultaneous recordings of variations in systemic blood pressure and ocular tension.[15] Sudden increases in global tension immediately consequent to rises in arterial pressure speak for elevated intraocular capillary pressure due to augmented vascular inflow. It may therefore be inferred that, subject to modification by autonomic nervous and hormonal influences and local physicochemical processes, the blood flow to the eye, as to other structures, is directly influenced by the arterial blood pressure. The effect on ocular tension of sudden increases in systemic pressure is recordable because the compensating actions of those agencies that regulate vascular tone do not immediately neutralize the effects of heightened pressure. Methods to increase the blood flow to the eye by transient increases in systemic blood pressure were therefore explored.

Although the blood pressure can be elevated by many drugs, such as pituitary extract, epinephrine and various other sympathomimetics, these were not employed because of such incidental pharmacologic effects as local vasoconstriction, which might have interfered with the physiologic responses to increased intraocular pressure which we wished to study. Elevations in blood pressure that might be produced by exercise, such as repeated elevation of the legs, or by pain induced with the prick of a needle were found to be too inconsistent to be of value for our purpose.

In 1933, Hines and Brown [16] described the so-called cold pressor test, whereby sudden transient elevations in blood pressure were produced, the degree apparently being dependent on the lability of the vascular regulatory processes. These investigators stated the belief that the vasopressor reaction was probably of neurogenic origin and that its speed and the fact that it occurred in adrenalectomized dogs indicated that the production of epinephrine was not concerned in the response evoked. In tests performed on over 500 patients of all types, elevations in blood pressure occurred in 99 per cent of the subjects, with mean elevations in normal persons of 11.4 mm. of mercury in systolic pressure and 10.6 mm. of mercury in diastolic pressure. In patients with severe hypertension these increases were 47.2 and 34.3 mm. respectively. Intermediate groups demonstrated labilities of pressure between these two extremes. Peak elevations occurred between one-half to one minute after the cold application, and the pressure usually returned to the original level in about two minutes. In no instance was any seriously adverse side effect noted.

It seemed to us that this method of inducing sudden increases in blood pressure might be used to augment transiently the blood flow to the eye, and so to increase ocular tension. The technic employed for the cold pressor test was similar to that described by its originators.[16b] With the patient prepared, and with blood pressure and tonometric readings taken as described, one of the subject's hands was immersed over the wrist in water at a temperature of 4 C. for one minute. The blood pressure and the ocular tension were measured after one minute and then at the intervals previously outlined. Since the vasopressor effect of cold is transient, readings were necessarily quick and prompt. For expediency, blood pressure recordings were usually made immediately after, and not exactly simultaneously with, the measurement of intraocular pressure, and so the correlation between the two, as observed, was not exact.

It was not our purpose to study intensively the effect of the cold pressor test on systemic

14. Cordes, F. C.: Early Simple Glaucoma: Its Diagnosis and Management, Arch. Ophth. **17**:896 (May) 1937.

15. Duke-Elder,[2] vol. 1, p. 512.

16. Hines, E. A., Jr., and Brown, G. E.: (*a*) Ann. Int. Med. **7**:209, 1933; (*b*) Am. Heart J. **11**:1, 1936.

blood pressure and ocular tension; rather, we wished to explore its acceptability as a means of increasing the ocular blood volume and so of influencing the pressure within the globe. For the purpose of our investigation, it was necessary to determine whether or not the effect of the cold pressor test on arterial pressure was consistent and comparable in patients with and without glaucoma. It was also necessary to know whether an increase in blood supply to the eye so induced, and reflected in changes in intraocular pressure, was affected by such individually variable factors as systemic hypertension and the associated instability of regulation of arterial pressure.

Of 32 patients without glaucoma, appreciable increases in blood pressure in response to the cold pressor test were recorded in 30, with an average rise of 21 mm. of mercury in systolic pressure and of 11 mm. of mercury in diastolic pressure. The range of increases was from 8 to 60 mm. in systolic pressure and from 2 to 30 mm. in diastolic pressure. According to the standard suggested by Fishberg,[17] 5 of these patients might be considered hypertensive, and in this small group, all of whom showed an elevation in blood pressure, the average increase was 32 mm. systolic and 13 mm. diastolic. The greater lability of blood pressure in these patients is in accordance with the observations of Hines and Brown.[16a]

Of 24 patients with chronic simple glaucoma, an increase in blood pressure in response to this test was recorded in 22, with an average rise of 22 mm. of mercury in systolic pressure and of 11 mm. of mercury in diastolic pressure. The range of increases in systolic pressure was from 2 to 60 mm. and in diastolic pressure from 2 to 26 mm. of mercury. Of these 24 glaucomatous patients, there were 8 with clinical vascular hypertension. In these 8 patients there was again noted a more conspicuous elevation of systolic and diastolic pressure in the cold pressor test than occurred in the glaucomatous patients with normal blood pressures, an observation similar to that made concerning the hypertensive patients of the control series.

While the number of patients so tested is too small for definitive conclusions to be drawn, it is striking that the sudden transient elevations in arterial pressure induced with the test occurred with some consistency, were of appreciable magnitude and were essentially similar in normal and in glaucomatous patients.

17. Fishberg, A. M.: Hypertension and Nephritis, ed. 4, Philadelphia, Lea & Febiger, 1939, p. 213.

The simultaneous effect of the cold pressor test on blood pressure and on ocular tension was observed in 28 eyes of 17 patients without glaucoma and in 10 eyes of 7 patients with proved chronic simple glaucoma. The latter group at the time of this examination were receiving no medication and did not have an ocular tension of over 30 mm. of mercury Schiøtz. It was considered desirable, for purposes of comparison, to consider only those eyes with glaucoma in which tension was within normal limits at the time of examination, though abnormal levels had at previous times been recorded in every case. This was advisable since with elevated tensions the decreased elasticity of the sclera due to stretching tends to cause much greater increases in intraocular pressure per volumetric increase in global content than occur at normal pressure levels.

It was found that an elevation in ocular tension during the cold pressor test occurred fairly

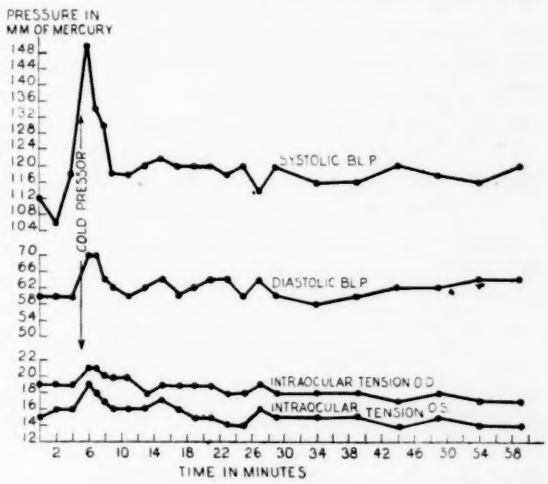

Fig. 1.—Typical curves of variations in blood pressure and ocular tension resulting from application of the cold pressor test to a patient without glaucoma.

consistently but was so small that it often fell below the limits of accuracy of our measuring instrument. Thus, of the 28 normal control eyes, 24 showed an increase in global pressure ranging from 1 to 4 mm. of mercury Schiøtz, with a mean elevation of 2 mm. Figure 1 illustrates the typical response in tension of a normal eye to the cold pressor test, with simultaneous recording of changes in vascular pressure. Of the 10 glaucomatous eyes with tensions at normal levels, 9 showed increases in pressure, ranging from 1 to 4 mm. of mercury, with an average rise of 2 mm. All tension curves returned to approximately the original levels after two minutes, as did the response in blood pressure.

These values are too small to permit any inferences to be drawn in a quantitative comparison

of the two groups. However, the one noteworthy fact disclosed in all these 38 eyes was that the rise in ocular tension was not at all proportional to the elevation in arterial pressure which was observed simultaneously. In other words, the systemic vascular response, which apparently occurred similarly in glaucomatous and in nonglaucomatous patients but which varied in degree in the individual patient, seemed to have a relatively constant effect on the blood flow to the eye and on the ocular tension, which was not appreciably influenced by the individual lability of the blood pressure control, within the limits of our instrumental accuracy.

With the requirement for a means to induce an augmented blood flow to the eye through the elevation of arterial pressure apparently satisfied by the cold pressor test, a method for interfering with the drainage of fluid from the eye was sought. Though the precise mode of drainage of aqueous from the globe is still disputed, its ultimate passage, together with the blood from the interior of the eye into the intracranial and facial venous systems, is unquestioned. Venous drainage is continued principally through the internal and external jugular veins, with a relatively small channel existing via the suboccipital plexus into the vertebral and deep cervical veins.[18] A moderate pressure of 40 to 50 mm. of mercury applied around the neck was shown by Schoenberg [19] to interfere with the patency of the jugular veins and thus to embarrass ocular venous drainage. This degree of compression, while apparently adequate to occlude the large veins of the neck,[20] could not, of course, interfere with arterial blood flow because of the much higher pressure present in the arteries.

Wessely,[21] in 1906, and Schulze, in 1901,[21] wrote of the rise in intraocular pressure that followed compression of the neck. Thiel [21] noted the elevating effect on ocular tension of venous engorgement induced by lowering the head for a period. He also resorted to the heroic expedient of constricting the jugular veins by cervical pressure for one to two and a half hours and produced a degree of ocular hypertension which only in glaucomatous eyes persisted through the period of cervical compression. This, he surmised, indicated a deficiency in regulation of pressure in such eyes. Schoenberg [19] suggested that measurable cervical compression could be secured by applying a sphygmomanometer cuff to the neck and showed that the intraocular pressure rose during the inflation of the cuff. The diagnostic implications of this procedure were recognized, but in the results published no consistent differentiation between glaucomatous and nonglaucomatous eyes on the basis of the reaction to venous obstruction was apparent.

The interference with ocular venous drainage provided by lowering the head seemed too variable a means of raising intraocular tension, and the recording of its effect with the tonometer, in that position, was most inconvenient. On the other hand, the easy applicability and simple standardization possible with cervical compression recommended the latter procedure for our purpose. To study its possibilities, another control series of patients were tested with the following technic:

A sphygmomanometer cuff was applied with comfortable laxness about the patient's neck, and another cuff was applied to his arm. The procedure was explained to the patient to allay his anxiety, and he was permitted to lie quietly supine to assure basal levels of blood pressure and ocular tension. When the pressures had apparently reached equilibrium, the stimulus was applied by inflating the cuff about the patient's neck to 40 to 50 mm. of mercury, as recorded on the sphygmomanometer, and maintaining this pressure until after the tonometric reading had been taken. This was done exactly after one minute of cervical compression, simultaneously with a recording of arterial pressure. Readings were then continued after release of the cervical compression, with the patient at rest, at the intervals described. Such transient cervical compression was safely tolerated by all patients tested, without excessive discomfort.

Forty-seven eyes were so studied. Twenty-nine of these were in 17 patients without glaucoma. This number included 12 eyes with cataract, 3 with aphakia and 14 without apparent abnormality. No difference in response of these various groups was noted. Measurable increases in ocular tension occurred in 21 of these 29 eyes, but in 16 they were 3 mm. or less of mercury Shiøtz so that their magnitude frequently fell below our limit of accurate measurability. The range of elevations varied from 1 to 7 mm. of mercury, with an average rise of 3.2 mm. In these, as in all other eyes so tested, the tension returned to the original base line or slightly below within one minute of the release of cervical compression. Figure 2 contains a typical curve of response of the intraocular pressure to cervical compression, with simultaneous recording of variations in blood pressure.

Of these 17 patients without essential glaucoma, 9 showed a measurable increase in arterial pressure during jugular compression, ranging

18. Gray, H.: Anatomy, edited by T. P. Pick, ed. 13, Philadelphia, Lea Bros. & Co., 1893, p. 653.

19. Schoenberg, M. J.: Remarks on Artificial Induction of Ocular Hypertension by Compression of Jugular Veins, Arch. Ophth. **1**:681 (June) 1929.

20. Starling, E. H.: Principles of Human Physiology, ed. 4, Philadelphia, Lea & Febiger, 1926, p. 808.

21. Cited by Schoenberg.[19]

from 4 to 16 mm. of mercury systolic and 2 to 6 mm. of mercury diastolic, with average rises of 9 and 4 mm. respectively. While these elevations were not high, it was noticeable that there was a qualitative correlation between the occurrence of elevation of systemic blood pressure and the degree of rise of ocular tension during this test. Thus, the average rise in ocular tension in patients with no elevation in arterial pressure was 1.7 mm. of mercury Schiøtz, as compared with an average rise of 3.4 mm. in patients whose systemic blood pressure showed a coincidental elevation. These differences are too small to be conclusive, but they are suggestive of the influence of variations in arterial pressure on responses of global pressure to cervical compression.

Nine eyes, in 6 patients with proved chronic simple glaucoma who, though under no medication at the time of the experiment, had ocular tension of less than 30 mm. of mercury, were studied for purposes of comparison. Elevations in ocular tension followed compression of the neck in 8 of these eyes, ranging from 2 to 19 mm. of mercury, with an average rise of 7.3 mm. Although this would seem to be significantly higher than the rise in global pressure that occurred in nonglaucomatous eyes, in this series there were several eyes with established glaucoma in which the rise in tension was below the average for the normal group, and a marked overlapping of the range of elevation in the two series of eyes generally precluded the drawing of diagnostic inferences. These results are similar to those published by Schoenberg.[19]

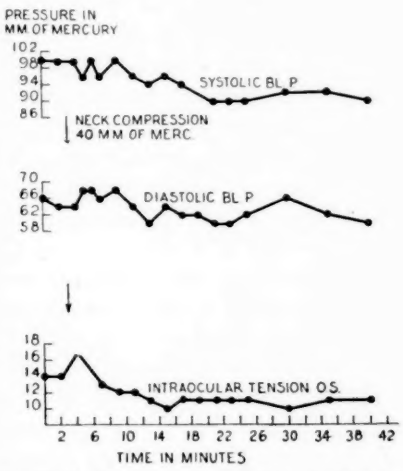

Fig. 2.—Typical curves of variations in blood pressure and ocular tensoin when cervical compression of 40 mm. of mercury was applied for one minute. In this instance no appreciable rise in blood pressure occurred.

In this glaucomatous group, it was again noted that in 4 of the 6 patients an appreciable rise of arterial tension occurred during the test, averaging 13 mm. of mercury systolic and 6 mm. of mercury diastolic. Although no quantitative relation between the rise in ocular tension and the rise in blood pressure could be established, it was obvious that in the 4 patients with elevated vascular tension the rise in intraocular pressure was much higher, i. e., an average of 8 mm. of mercury, as compared with an average rise of 1.2 mm. of mercury in the 2 patients with glaucoma in whom no elevation in arterial pressure occurred during the test.

A third group of 9 eyes with chronic simple glaucoma, in 6 patients whose ocular tension without medication was over 30 mm. of mercury, were tested with cervical compression. Here it was found that elevations in tension occurred ranging from 2 to 25 mm. of mercury, with an average rise of 12 mm. Here, again, however, a marked overlap of the range of elevations with that of the normal group was present, and once more the qualitatively greater rise in tension was noted when elevation of arterial pressure occurred.

It seems apparent that while some difference in the response of glaucomatous and that of normal eyes to simple jugular compression exists, no diagnostic value can be attached to the test in individual cases. However, it seems that one factor contributory to variability in intraocular pressure was ignored in these early tests based on cervical constriction, namely, the coincidental psychic effect on systemic blood pressure. It is obvious that even in moderately apprehensive patients an increase in blood pressure might take place during such a procedure which would augment the effect of the cervical compression on ocular tension beyond that which would occur in a more phlegmatic subject with unaltered arterial tension. One may suppose that while the outflow of blood from the eye is impeded with some uniformity by the test, the inflow is not only uncontrolled but excited to individually varying degrees. These inferences are supported by the variations in arterial pressure that occurred during our tests and by the correlations found to exist between such rises in vascular pressure and the degree of response in ocular tension simultaneously noted. It seemed to us, therefore, that by increasing arterial pressure with some consistency and so augmenting the inflow of blood in each case simultaneously with the constriction of jugular vessels, a more comparable elevation in ocular tension would result in all instances. It was thought that this concurrent effect might be secured with some constancy by the simultaneous application of the cold pressor and the

jugular compression test, and a simple method of combining the two was devised.

METHOD FOR TESTING LABILITY OF OCULAR TENSION

The patient lies supine and is asked to look at an object directly over his head to insure a fixed vertical position of the eyes for tonometric recording. A sphygmomanometer cuff is placed loosely about his neck. After a short period of rest, two or three tonometric readings are taken at brief intervals to establish the base line of ocular tension for that patient. One of his hands is then immersed over the wrist in ice water (4 C.). Simultaneously the cervical cuff is inflated to a pressure of 40 to 50 mm. of mercury, as recorded on the attached manometer, and is maintained at that level during the period of the test. The ocular tension is measured quickly and promptly after one minute, and the ice water is then removed and the cuff deflated.

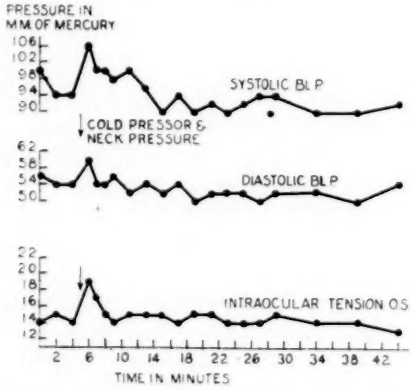

Fig. 3.—Typical curves of variations in blood pressure and ocular tension when the combined cold pressor test and cervical compression were applied for one minute.

Early in our investigation the measurements were taken as previously described over a long period. A typical curve of response in tension to the combined stimuli is illustrated in figure 3. However, we found consistently that in all eyes elevations in tension so induced returned to the level of the original pressure within two minutes after the stimuli were removed, so that no measurable difference could be shown to exist between different eyes in the time required for the reestablishment of the original pressure level. Accordingly the basal ocular tension before application of the stimulus and the tonometric reading immediately thereafter were considered sufficient data for the clinical interpretation of the test.

Furthermore, in a series of 17 normal patients, measurements of blood pressure were taken simultaneously with the recording of ocular tension during the performance of this test. All showed an elevation of systolic and diastolic pressure similar to that produced by the cold pressor test alone, as previously studied, and once more it was observed that the tension reaction in the eye was not proportional to the vasopressor response shown by the change in arterial pressure. It was therefore felt that in the clinical performance of the test a control record of variation in blood pressure was unnecessary.

A total of 96 eyes in 56 patients were first studied. The average age of the patients without glaucoma was about 48 years, and all but 8 of the subjects were more than 35 years old; this selection was made to insure an age level comparable with that of the group with chronic simple glaucoma. Seventy-seven nonglaucomatous eyes were studied, including many with various degrees of cataract development, some with postoperative aphakia and a majority with no apparent ocular abnormality. There was no consistent difference in response of any of these subgroups of the nonglaucomatous eyes.

Of these 77 eyes, 75 exhibited an increase of ocular tension with this combined stimulus, while 2 showed no change. In 71 eyes the increase ranged from 1 to 9 mm. of mercury Schiøtz; and in a single eye in 2 patients and in both eyes of another patient the elevations were 12, 10, 17 and 11 mm. of mercury respectively. It is regrettable that the opportunity was not afforded to study these 3 patients more extensively in order to check on the nonglaucomatous evaluation of their condition, but it may be noteworthy that 3 of these eyes presented an intumescent cataract and a shallow anterior chamber. An attempt will be made to obtain a follow-up study of these patients to determine the possible presence of a glaucomatous diathesis. The average rise in tension in all the nonglaucomatous eyes tested was 5 mm. of mercury.

Nineteen eyes in 14 patients with chronic simple glaucoma all of which had at some time shown increased tension and for which the diagnosis was unquestioned were chosen for comparative study. None of these eyes had undergone operation of any type, and at the time of our study they had not been exposed to medical therapy for at least twenty-four hours. These restrictions were thought advisable to avoid any conflicting reactions that might be induced by operative intervention or pharmacologic effects. For purposes of comparison with the normal group, 7 eyes with glaucoma simplex in which the tensions at the time of our study were all below 26 mm. of mercury Schiøtz were first tested. The elevation in ocular tension produced

in this group ranged from 9 mm. of mercury, in 1 eye, to 19 mm. of mercury, with an average rise of 13.5 mm. In the other group, of 12 eyes in 8 patients with chronic simple glaucoma, in which the ocular tension at the time of the test was 30 mm. of mercury or over and ranged up to 48 mm. of mercury, the variation in elevation of global pressure was from 8 to 30 mm. of mercury, including a single instance of ocular tension of 8 mm. and another of 9 mm. of mercury. The average rise of tension in this group was 14.8 mm. of mercury. The actual changes in tension that occurred in all eyes tested are graphically recorded and grouped in figure 4.

It is thus indicated that the procedure described is capable of inducing an easily appreciated, transient rise in ocular tension with some consistency. Our results in the series of tests made thus far suggest that there is a difference in the degree of elevation which occurs in nonglaucomatous eyes and that which occurs in eyes

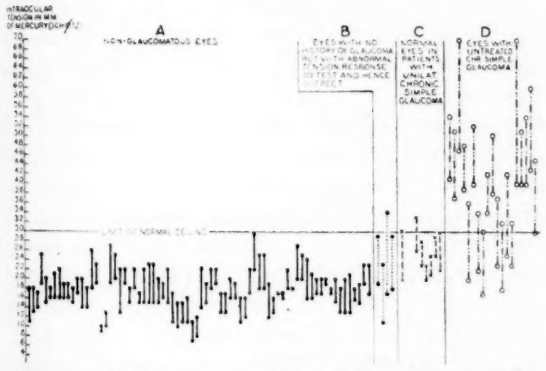

Fig. 4.—Graphic representation of elevations of tension and ceilings of pressure attained in response to simultaneous application of the cold pressor test and cervical compression in eyes without known glaucoma, in normal eyes of patients with unilateral chronic simple glaucoma and in eyes with chronic simple glaucoma which had received no medical or surgical treatment.

with chronic simple glaucoma, an arbitrary figure of 9 mm. of mercury approximately indicating the maximal rise occurring in normal eyes. An elevation above this figure may be considered at least suggestive of morbidity.

In examining the results of these experiments, another interesting observation was made. In addition to noting the degree of elevation in ocular tension that occurred, the absolute height to which the pressure in each eye rose was recorded. In conformance with the terminology applied by Hines and Brown [16b] to variations in arterial pressure, such elevated levels of ocular tension might be referred to as the ceiling of pressure reached in each case.

As shown in figure 4, of the 77 nonglaucomatous eyes studied, this ceiling was over 30 mm. of mercury in only 1, that in which the highest elevation of 17 mm. of mercury was recorded, and a level of 34 mm. of mercury resulted. Ceilings for the remaining 76 eyes ranged from 15 to 30 mm. of mercury, the latter level being reached in only 1 eye. The average height of the pressure ceilings reached in this control group was 20.3 mm. of mercury.

In the 7 eyes with chronic simple glaucoma but with initial tensions within the normal range, comparable to those of the nonglaucomatous eyes, the ceilings at the end of the tests ranged from 30 mm. of mercury, in 1 instance, to 43 mm. of mercury, with the average height in intraocular pressure elevated to 35.4 mm. of mercury. In the 12 eyes with chronic simple glaucoma in which the initial pressures had been over 30 mm. of mercury, the ceiling levels reached were, of course, in a much higher range, namely, 48 to 74 mm. of mercury.

If one accepts 30 mm. of mercury as an upper limit for the normal pressure within the eye, as measured with the Schiøtz tonometer,[22] it is apparent that in only 1 of 77 nonglaucomatous eyes so tested did the ceiling of ocular tension rise above this level. On the other hand, in every eye with chronic simple glaucoma thus examined this figure was either reached or exceeded. These facts are illustrated graphically in figure 4.

While there is a fairly consistent correlation between the degree of elevation of tension and the height of the ceiling reached, this is not constant. Three eyes without definite glaucoma were noted in which, in spite of an abnormal degree of elevation of pressure with this test, the level of tension reached, though moderately high, was still within normal limits. Conversely, there were 3 eyes with compensated glaucoma in which, because of an initial relatively high level of tension, a maximally normal degree of elevation occurred that sufficed to raise the ceiling to abnormal heights. It seems therefore that while the higher degrees of elevation would tend to raise the level of intraocular pressure during the test to abnormal heights, in the unusual cases in which the original pressures were sufficiently low, this did not occur. Though the increased lability of tension in such cases, indicated by abnormal rises in pressure, may be considered a constant threat of morbidity, its potentially noxious effect may be neutralized by the physiologic low tension level, and such eyes, accordingly, showed no glaucomatous stigmas. When, however, the original pressure was apparently geared to a higher level, even an only slightly high lability of tension, expressed by an elevation of moderate

22. Duke-Elder,[2] vol. 1, p. 501.

degree, was sufficient to raise the ceiling to abnormal amounts. Such eyes, in our series, showed clinical evidence of glaucoma. It is suggested, therefore, that while demonstrably abnormal lability of tension might be considered contributory to morbidity, an abnormally high ceiling of tension is even greater evidence of a tendency toward intraocular hypertension. Furthermore, while the value of the rise of tension demonstrated by this test depends on the recording of a truly basal level initially, the validity of the ceiling pressure noted is independent of the actual physiologic level.

It should be noted that, just as Hines and Brown [16b] demonstrated the approximate consistency of the responses to the cold pressor test in any individual subject, the elevation in ocular tension induced by this test remained qualitatively the same with repeated experiments on the same eye. When the test was repeated on 15 eyes in normal subjects and on 15 eyes of persons

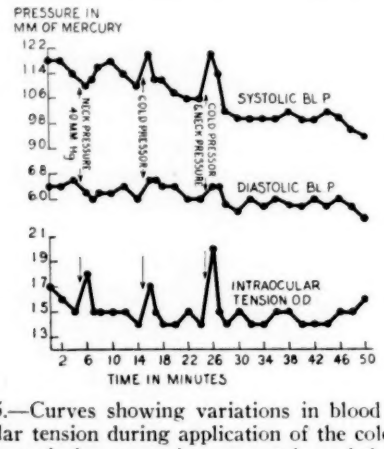

Fig. 5.—Curves showing variations in blood pressure and ocular tension during application of the cold pressor test and cervical compression separately and then simultaneously to a patient without glaucoma.

with chronic simple glaucoma, though differences in degree of elevation of tension up to 5 mm. of mercury were noted, in no instance was the variation great enough to change the result from normal to abnormal or vice versa. The most significant change occurred in an eye with glaucoma in which on repetition the elevation of tension was 7 mm. of mercury, as compared with a previous 11 mm. and the ceiling of pressure changed to 29 mm. of mercury from the earlier 34 mm. The interpretation here necessarily was altered from that of definite to that of suggestive abnormality in the regulation of ocular tension.

More than 50 eyes were tested with the separate application, at sufficient intervals, of the cold pressor test and of cervical compression and then with the two procedures simultaneously. A typical curve of variations in ocular tension and blood pressure so produced is shown in figure 5. Our purpose was to investigate the individual contribution of each stimulus to the combined effect on ocular tension. No constant relationship was discernible between the elevating effect on global pressure of either individual stimulus and the response to the combination of the two. It was apparent, moreover, that the combined effect on tension was not a simple quantitative summation of the responses of the individual stimuli. It was further noted that when both eyes in 1 patient without glaucoma were tested, the response of ocular tension to the stimuli applied individually and in combination was qualitatively, but not quantitatively, similar in the two eyes. In patients with bilateral or unilateral glaucoma, the elevations in tension produced in the two eyes by these stimuli seemed unrelated to each other.

COMMENT

Although the number of cases here studied is not large, from the data thus derived certain interesting impressions emerge. The simultaneous application to a patient of the cold pressor test and jugular compression fairly consistently results in a measurable increase in ocular tension. The amount of elevation that occurs in response to this easily standardized combined stimulus may be regarded at least as a qualitative expression of the lability of intraocular pressure and is appreciably greater in some eyes than in others. In the small series of cases we studied, the eyes in which lability of tension seemed highest almost uniformly were afflicted with chronic simple glaucoma, a finding conforming to the concept previously discussed, that the disease may be considered due to an aberration in the homeostasis of intraocular pressure. However, since the precise disturbance underlying essential glaucoma is disputed, it is permissible only to say that abnormal lability of tension as demonstrated by this test seems to be present in chronic simple glaucoma and, when found in an eye, may be associated with that disease. We have not yet had the opportunity to study the reaction to this test of a sufficient number of eyes with secondary glaucoma to be able to demonstrate satisfactorily a differentiating reaction in such eyes. We are also studying the response to this test of eyes subject to acute congestive glaucoma.

The precise mechanism whereby the rise in intraocular pressure occurs in response to this combination of stimuli is uncertain. It seems probable that a sudden engorgement of intraocular tissues is produced. In accordance with the mechanism suggested by Gradle [10c] to explain

the rise in tension occurring in many so-called provocative tests, it might be assumed that a swelling of the iris root results that might occlude the angle of the anterior chamber. He stated the belief that this might embarrass drainage of intraocular fluids sufficiently to increase intraocular pressure to a degree depending on the width of the angle and the relative swelling of adjacent tissues. However, the speed with which the increase and decline of pressure occurs here renders such an explanation unlikely. Furthermore, the depth of the anterior chamber as clinically estimated seemed to bear no relation to the degree of ocular response to this test.

If one attributes the rise in tension to the sudden congestion of intraocular tissues caused by the combination of interference with venous drainage and an increase in vascular inflow, another explanation of the variation in response in different eyes readily offers itself. One might assume the presence of a reflex arc coordinating vascular inflow and outflow within the eye for the purpose of preventing excessive intraocular congestion. The application of jugular compression might therefore initiate a marked compensatory vasomotor reaction in the afferent arterioles of the eye, to effect a diminution in inflow of blood. It is obvious that the strain put on such a vasoconstriction by a simultaneous rise in systemic blood pressure that would augment the flow of blood to the eye might overcome this compensatory mechanism in varying degrees in different eyes and result proportionately in congestion and ocular hypertension. It follows that this test may measure the effectiveness of such a protective vasoconstrictive reflex, and an abnormal increase in tension so demonstrated may indicate a breakdown in the arc that may be associated, though not necessarily etiologically, with chronic simple glaucoma.

It has been suggested that the impairment of such vascular coordination may be a precursor to actual glaucoma, and its demonstration might therefore reveal a glaucomatous diathesis. In 6 out of 8 apparently normal eyes of patients with unilateral chronic simple glaucoma, however, normal lability of ocular tension was present. The average rise of tension in these few eyes was 5.8 mm. of mercury, and the mean ceiling reached was 26.3 mm. of mercury. These figures, though higher than the corresponding averages of 5.0 and 20.3 mm. in the control group, cannot be considered definite evidence in favor of such a contention. However, it is suggestive that they tend to fall between the values for the normal and those for the glaucomatous group. The results of the test on these cases are illustrated in figure 4.

The nature of such a coordination of the ocular vascular system is conjectural. It may be nervous or physicochemical or both, and may be either completely intrinsic to the eye or mediated through extraocular autonomic agencies. In regard to the latter possibility, it may be mentioned that in 1 eye with a complete Horner syndrome the lability of ocular tension thus tested was well within normal limits.

The effect of various drugs on the response to this test is now being studied. These investigations are not yet completed, but it may be mentioned at this time that pilocarpine in clinical dosage appreciably reduced the abnormal lability of tension, as demonstrated by this test, in each of 13 eyes with chronic simple glaucoma which had not been operated on. The elevations in tension produced by this combined stimulus

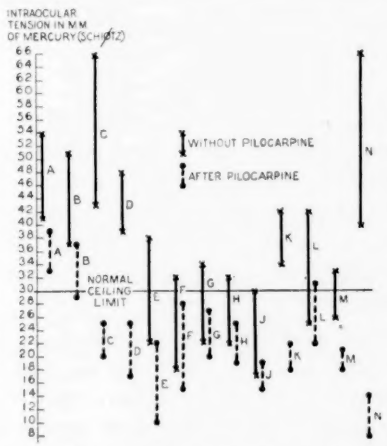

Fig. 6.—Graphic representation of elevation of tension and ceiling of pressure reached in eyes with chronic simple glaucoma which had not been operated on after simultaneous application of the cold pressor test and cervical compression, before and after instillation of pilocarpine. Each eye is denoted by an individual letter.

before and after the instillation of pilocarpine in these eyes are illustrated in figure 6. Furthermore, it was indicated in these eyes that only when the glaucomatous hypertension was clinically controlled successfully with pilocarpine was the abnormal lability and ceiling previously demonstrated in the absence of the drug reduced to normal range after pilocarpine had been instilled. Such a stabilizing effect of pilocarpine on the lability of intraocular pressure was less certain in normal eyes, occurring in 11 out of 17 nonglaucomatous eyes, and to a degree usually so small that it fell below our range of accurate measurement. There is some evidence based on such experiments on a glaucomatous eye with fixed pupil that this action of pilocarpine on

the abnormal lability of tension in glaucoma is independent of its miotic effect. The implication is apparent that pilocarpine and pharmacologically related drugs may play a role in the reflex arc previously mentioned as a possible coordinating mechanism between vascular inflow and outflow in the eye.

It may also be noted that in a small group of 7 eyes with chronic simple glaucoma which had undergone various filtering operations and in which no further therapy was required to control the pressure, the response to this test was normal in elevation and ceiling of tension in all instances. Conversely, abnormal rises of tension occurred in 4 out of 5 eyes with chronic simple glaucoma tested without medication when operation in itself had proved ineffectual in reducing tension to normal levels. These preliminary impressions are mentioned to suggest the possible value of this test in quickly estimating the therapeutic efficacy of pharmacologic or operative measures in any case of chronic simple glaucoma.

CONCLUSIONS

1. The normal maintenance of intraocular pressure within an optimum range suggests the presence of a regulatory mechanism.

2. Dysfunction of such a homeostatic system may result in abnormal lability of intraocular pressure and may eventuate in chronic simple glaucoma.

3. The method here described to test this lability may prove of value for the earlier diagnosis of chronic simple glaucoma and the evaluation of therapeutic measures for that disease.

1095 Park Avenue.

1010 Fifth Avenue.

DISCUSSION

DR. WILLIS S. KNIGHTON, New York: Dr. Lambert and Dr. Bloomfield are to be congratulated on their excellent presentation, and especially on the restraint which they have exercised in interpreting their results.

They have ingeniously combined two well known provocative tests for glaucoma so that the amount of induced vascular congestion is standard for each patient and can be reproduced at any time.

The results of other provocative tests in use at the present time are so uncertain that one does not dare deny the existence of glaucoma when the result is negative. But if the lability of intraocular pressure, as presented here, is an accurate indication of the glaucomatons status, it may yet be possible to prove the absence of glaucoma.

The only practical way to prove the validity of a test is to try it, and I have subjected 12 patients to this procedure. I should like to refer briefly to the results with some of them, as a sample.

The first 2 patients showed no evidence of glaucoma. One of them had nuclear cataracts. In neither patient was the variation of tension more than 4 mm. of mercury and the highest ceiling was 25 mm. of mercury. This is what one would expect in the absence of glaucoma.

Patient 3 had early glaucoma simplex. His ocular tension had never been over 35 mm. of mercury with other provocative tests; but there were early changes in the fields and his eyes were uncomfortable without the use of drops. The visual acuity, visual fields and ocular tension have been controlled for three years with weak solutions of pilocarpine, but when the dose has been reduced or the drops omitted, the tension has slowly risen above 30 mm. of mercury in one eye or the other. The drops were omitted for one week prior to this test, with the result shown. The tension in the right eye rose to 35 mm. of mercury, after an excursion of 8 mm., but the tension in the left eye dropped 2 mm.! It is interesting to note that the highest point in the tension in the right eye reached with this test did not exceed the maximum obtained with other provocative tests and no new information was added. I cannot explain the reaction of the left eye except to say that on previous occasions the eyes seemed to alternate in their manifestation of subjective symptoms and in the elevation of the tension. The paracentral fields were equally defective, and it would be difficult to say clinically which eye was the worse except for the occasional differences in tension. Perhaps some local control mechanism was in force at the time of this test, but if one were to rely on this single examination, one would be forced to the erroneous conclusion that the left eye was normal. A single test, obviously, is not conclusive.

Patient 4 had had an iridencleisis on the right eye after an acute attack of glaucoma. The tension remained at about 22 mm. of mercury without medication. The tension of the intact, left, eye seemed to be controlled with use of pilocarpine at night only. The pressor-congestion test indicated that the tension of the right eye was under control. It is interesting to note that the lability, as well as the level of the tension, was normal. It can hardly be argued that a simple paracentesis would have accomplished the same result by changing the characteristics of the aqueous, for this test was made about one month after the operation. Kronfeld has shown that the aqueous returns to its primary composition about two weeks after paracentesis. The tension of the intact, or left, eye rose to a suspicious height. Although pilocarpine was being used at night, the last drop had been administered fifteen or sixteen hours before the test, and the medication was probably insufficient.

Patient 5 showed the reaction of the tension after trephination of each eye. Again, the

lability, as well as the height, of the tension was normal.

Patient 6 had glaucoma six years ago; the tension of the right eye was 40 mm. of mercury, and there was a paracentral wing scotoma in each eye. Pilocarpine had been used for a short time and then discontinued. The patient has been without drops for six years, and clinically his glaucoma is no worse. The lability and height of tension are apparently normal. If these factors are an indication of the state of his glaucoma, he is not in danger.

Dr. Givner told me of another patient who showed a lability of tension of 17 mm. of mercury in the right eye and of 13 mm. in the left eye. The ceilings were 40 and 36 mm. respectively. Other provocative tests had failed to raise the tension to an amount which would incite suspicion. The clinical findings, however, included deep cupping and paracentral scotomas; so glaucoma was already evident. The test for lability merely indicated the degree of abnormality.

Excessive lability of the intraocular pressure is undoubtedly one of the earliest manifestations of essential glaucoma. Elevated tension must be present at some time in every case of true glaucoma. Even when glaucoma cannot be demonstrated, the only other changes that occur in the eye are those which have been proved to be secondary.

In other patients who had glaucoma without increased tension the disease was found to be secondary to calcification of the cerebral and ophthalmic arteries and was not true glaucoma.

I cannot agree with persons who say that primary glaucoma is caused by secondary changes in the eyes resulting from age, although such changes may be factors in modifying a pressure that is already aberrant. But the abnormal pressure comes first.

There must be a controlling mechanism to hold the normal pressure within such narrow confines, but its nature and location will have to await further investigation. It is difficult to visualize a central mechanism, such as Elwyn proposed, that would permit the disease in one eye to progress so much farther than that in the fellow eye. On the other hand, Friedenwald's conception of local ocular control fails to explain many things. The authors have postulated a reflex arc, location unknown, while admitting the possible influence of local factors coincident with age.

Regardless of the site of this control, it remains to be seen whether this pressor-congestion test will show an early lability of tension in advance of the present diagnostic methods. There is some indication that it may do so in cases of so-called unilateral simple glaucoma. I question the possibility that such a condition could exist, although Duke-Elder speaks of the other, "healthy," eye in cases of glaucoma. Other authors maintain that the second eye is not healthy but that undiscovered, preclinical glaucoma exists. The authors themselves found that the supposedly unaffected eyes showed lability of a degree that fell between that of the normal and that of the glaucomatous group. The interesting point is the suggestion that the second eye was not quite normal in its reaction. Perhaps a repetition of the test will give more positive information. The response in my own patient with chronic simple glaucoma demonstrated the fallibility of a single test.

Early glaucoma will never be easy to discover, and this test can do no more than indicate a variable in one of its phases. The lability of the tension will never be great in cases of questionable early glaucoma because, as is indicated by the low ceiling of tension, which makes the diagnosis difficult, fairly active compensatory factors are at work. Not the least of these is the elasticity of the corneoscleral coat, which takes up some of the increased pressure without transmitting it to the tonometer. As this elasticity diminishes, less intraocular pressure can be absorbed, and any increase in the volumetric content of the globe is more evident. But, at the same time, the ceiling tension is elevated, and the diagnosis is more apparent. The greatest help is needed in cases of early glaucoma with low tension.

As the authors have indicated, many interesting questions suggest themselves, such as the effects of various drugs and the reactions in cases of so-called secondary glaucoma.

In the meantime, this test is a practical, informative one, which will undoubtedly prove more valuable as it is better understood.

DR. HERMAN ELWYN, New York: The work of Dr. Lambert and Dr. Bloomfield is a valuable addition to the knowledge of glaucoma, whether the lability test turns out to be practical or not. The lability of the intraocular pressure which is characteristic of the early stages of chronic simple glaucoma can be measured with their test. The test also shows that this lability can be brought to normal with the use of pilocarpine. This is important, for it leads to certain theoretic deductions as to the pathogenesis of glaucoma.

Pilocarpine is a cholinergic drug, and it is known to act on the effector cells innervated by cholinergic nerve fibers. It is known that the normal intraocular pressure is maintained by cholinergic nerve fibers which act through the mediation of acetylcholine. This is demonstrated by the known action of physostigmine in preventing the destruction of acetylcholine by cholinesterase. Thus, in cases of increased intraocular pressure use of physostigamine permits acetylcholine to act on the effector organ and the intraocular pressure is reduced. The action of pilocarpine, which is the same as that of acetylcholine in normalizing the labile intraocular pressure of early glaucoma, seems to me to prove that the effector organ for the maintenance of the intraocular pressure is intact.

In early glaucoma, then, the effector organ is intact, and the chemical mediator is produced and reaches the effector organ at times, that is, when the intraocular pressure is normal. When the pressure is increased, acetylcholine can be made to reach the effector organ by preventing its destruction by means of physostigmine. Obviously, however, the chemical mediator is produced in uneven amounts—sometimes in amounts sufficient to maintain the normal pressure, at other times in insufficient amounts. Regulation of its production is at fault. But where is this fault located?

Acetylcholine is produced at the terminal nerve endings of the cholinergic postganglionic nerve fibers. Their production is not regulated there, for the impulse to production comes from the nerve cells, which are located in the ciliary ganglion. This ganglion, like all peripheral ganglions from which postganglionic nerve fibers arise, is not a regulatory center, but a distributive one for impulses coming from preganglionic fibers. Preganglionic fibers to the ciliary ganglion come from the small cells of the nucleus of the third nerve. Impulses for the continued uniform production of the chemical mediator at the nerve endings in the eye must be regulated from these cells, or from other centers in the brain which send impulses to these cells.

With the effector organ in normal condition in the early stages of glaucoma, as shown by the effect of pilocarpine in normalizing the labile intraocular pressure, the irregularity in the production of the chemical mediator can be due only to irregular impulses coming from the cells of the preganglionic nerve fibers, that is, from the centers in the brain. The work of Lambert and Bloomfield gives added evidence in support of the assumption that the primary fault in glaucoma is a disturbance in the regulatory center in the brain the function of which it is to maintain the normal intraocular pressure.

Dr. Ludwig von Sallmann, New York: I have had no experience with the new lability test, but many years ago I studied the two tests on which it is based. Kahler and I observed in normal human subjects the tendency to an inverse response of the blood pressure and the ocular pressure to thermal stimuli; that is, as the blood pressure increased with a cold stimulus, the intraocular pressure decreased slightly. These observations are at variance with the results in the present study. The statement of Dr. Bloomfield in regard to the unreliability of the jugular compression test is in agreement with general experience. It seems possible that the combination of two unsatisfactory tests may result in a useful diagnostic procedure. But would it not be more feasible to combine the jugular compression test with the heat stimulus test, since the latter sometimes produces a slight rise in the intraocular pressure?

Dr. Sylvan Bloomfield, New York: I wish to thank the discussers for their constructive comments.

We did not observe in our series a response like that which occurred in the patient in Dr. Knighton's series whose ocular tension fell on application of the stimuli. It is difficult for me to understand how the congestion induced in an eye with this test could result in a drop in intraocular pressure. I should be interested in a repetition of the test on that patient. I am also interested in his patient who had an episode of glaucoma which was followed by normal tension without treatment and who now, six years later, gives a normal response to our test. The only parallel I can think of occurred in 2 patients with acute congestive glaucoma who showed increased lability of ocular tension with this test during the acute episode and who, after medical control of the attack, gave a normal response a month or two later, when the disease was in a quiescent phase. I suggest the possibility that Dr. Knighton's patient had an episode of acute congestive glaucoma, rather than chronic simple glaucoma.

In answer to Dr. von Sallmann's question, I can only say that in almost all of a series of about 40 eyes on which we tried the cold pressor test alone, a definite, though small, increase in tension occurred, and this experience seems to agree with that of investigators who produce elevations in blood pressure by other means. There seems to be evidence that an increase in blood pressure often is associated with a transient rise in intraocular pressure.

I know nothing about the use of hot water for this purpose. It sounds interesting, and we may try it next.

Dr. Robert K. Lambert, New York: I think I can confirm Dr. von Sallmann's findings in one respect. In preliminary experiments at Montefiore Hospital, we studied the effect of elevating the blood pressure on the intraocular tension in normal persons. There must be an active compensatory mechanism at work, for the systemic injection of epinephrine and solution of posterior pituitary not infrequently produced a slight lowering of intraocular tension, after an initial slight rise. I do not believe this mechanism is as active in cases of glaucoma or of preglaucoma.

GONORRHEAL SYNDROME WITHOUT GONORRHEA

REITER'S DISEASE

LIEUTENANT COLONEL ROBERT L. LUCAS AND MAJOR HARRY WEISS
MEDICAL CORPS, ARMY OF THE UNITED STATES

The association of urethritis, conjunctivitis and arthritis and cutaneous lesions is a syndrome not uncommonly produced by the gonococcus.

Forty-seven cases [1] in which the gonococcus could not be found in relationship to this syndrome have been reported in the literature since 1912. The most recent article on this subject was one by Lever and Crawford,[1] who reviewed the subject from its dermatologic aspects.

The triad of urethritis, conjunctivitis and arthritis, occurring in this order, in the absence of a gonococcic etiology, has come to be known as Reiter's disease.[2] The syndrome parallels gonorrheal infection so closely that suspicion of the gonococcus is difficult to dispel.

Urethritis has been reported in all cases of this disease. The anterior and posterior urethra are involved, often with cystitis. It resembles the usual gonorrheal infection. For this reason it is difficult to recognize it apart from gonorrhea unless smears have been repeatedly negative and the course of the disease has been followed until its later stages.

Conjunctivitis is a constant finding. It is acute in onset, purulent in character, usually with bilateral involvement. A tendency to spontaneous recovery without corneal ulceration is the rule. Keratitis and iritis have not been uncommon complications. The ocular symptoms ultimately subside, with full restoration of vision.

In the case reported a crop of small vesicles developed chiefly in the central area of the cornea five days after the onset of the conjunctivitis. These broke down shortly, to form discrete superficial ulcers which showed no tendency to coalesce or penetrate and healed without residual opacification within the ensuing three weeks. Photophobia was intense during this period. The iritis followed the keratitis after an interval of five days. It was of the acute plastic variety and accompanied by hyphemia at its onset. The involvement of the left eye was similar but milder in degree.

Chronic arthritis is ordinarily the severest complaint. More than one joint is usually involved and most frequently those of the toes, ankle, wrist and knee. The arthritis persists the longest but generally clears up in from one to five months, leaving no permanent stiffness or ankylosis.[3]

Cutaneous lesions may be simple erythemas, urticarial or erythema nodosum–like eruptions, hemorrhagic and vesicular eruptions or hyperkeratotic lesions. To the dermatologist, its chief interest lies in the keratotic cutaneous lesions which have appeared in roughly 40 per cent of the cases reported. The cutaneous manifestations have been typical or similar to those seen in keratosis blenorrhagica. Hence this syndrome has also been termed "keratosis blenorrhagica without gonorrhea." [4]

Forty-six of the cases reported have occurred in young men. One case has recently been reported in a white woman. Only one death has been reported [1]; it was attributed to a myocardial infarct. The disease cannot be distinguished from a gonorrheal infection clinically. Bacteriologic studies are the only means of differentiation. Failure to respond to sulfadiazine and penicillin also sets this syndrome apart. The course of the disease is usually milder, and complete recovery is the rule. Recurrences have been reported as late as six years after the original onset. The cause of Reiter's disease is unknown. No remedy has been found to be of specific benefit.

REPORT OF A CASE

History.—A man, aged 29, noticed a urethral discharge, purulent in character, on June 28, 1944, ten days after exposure. There was no history of previous urethral discharge. Three days later he sought the attention of a general practitioner who, without

1. Lever, W. F., and Crawford, G. M.: Keratosis Blennorrhagica Without Gonorrhea (Reiter's Disease?), Arch. Dermat. & Syph. **49**:389 (June) 1944. Complete bibliography.

2. Reiter, H.: Ueber einer bisher unbekannte Spirochäteninfektion (Spirochaetosis arthritica), Deutsche med. Wchnschr. **42**:1529, 1916.

3. Comroe, B. I.: Arthritis and Allied Conditions, ed. 2, Philadelphia, Lea & Febiger, 1941.

4. Buschke, A.: Ueber die sog. "Gonorrhoischen Hyperkeratosen" ohne Gonorrhoe, Klin. Wchnschr. **7**: 1133, 1928.

taking a smear, prescribed eight (0.5 Gm.) tablets of sulfathiazole daily and a medication to be used for urethral irrigation.

Some diminution in the quantity of discharge ensued during the next two weeks, at which time he was instructed to change to four (0.5 Gm.) sulfadiazine tablets daily. During the next six days the urethral discharge subsided considerably, but on July 21, 1944 both eyes became congested. On the next day there was a profuse purulent discharge present in both eyes.

On July 23, 1944, the patient first came under our observation because of the intensity of the conjunctivitis. Examination disclosed intense congestion of the palpebral and bulbar conjunctiva of each eye associated with a purulent secretion. Mild edema of both upper lids was present. The patient complained of marked photophobia.

A short time after irrigation the conjunctival sac refilled with pus. Slit lamp study revealed no evidence of involvement of the cornea or iris.

Laboratory Examination.—A smear was taken and sent directly to the laboratory, gonococcal conjunctivitis having been suspected because of the clinical appearance and the history of recent urethritis.

The laboratory gave the following report. The conjunctival smears were negative for intracellular or extracellular gram-negative cocci. In the urethral smears (three consecutive days) no intracellular gram-negative diplococci were found. The urethral culture, the blood culture, the culture of the cutaneous lesions and the culture of the synovial fluid of the right knee were negative for the gonococcus. The serologic reactions to the Kahn test were negative. The blood count (three days after admission) was: erythrocytes 4,790,000, hemoglobin 16.8 Gm., white blood cells 10,700, neutrophils 81, lymphocytes 13, monocytes 4, eosinophils 1 and basophils 1.

Treatment and Course.—In spite of the laboratory report, again because of the history and clinical resemblance to blenorrhagic conjunctivitis, the patient was hospitalized and placed on the following medication: penicillin 20,000 units intramuscularly statim, to be repeated each four hours; conjunctival irrigations with boric acid solution every two hours. Twenty-four hours later, there being no improvement, ocular irrigations were ordered hourly, and 10 Gm. of sulfadiazine orally were administered in divided doses. Since no improvement was noted the sulfadiazine and penicillin were discontinued after a total of 170,000 units had been administered. Nine days later another course of 100,000 units was administered within twenty-four hours, without benefit.

Three days after admission to the hospital the interphalangeal joints of the second and third toes became swollen and painful. During the next four days the right heel, third and fourth toes of the left foot, left wrist and right knee progressively were involved.

The conjunctival discharge and edema of the lids subsided slowly but steadily after admission to the hospital; but in no manner was the response similar to that usually seen when penicillin or sulfadiazine is used. Coincident with the onset of the arthritis a cluster of superficial vesicles was observed in the central area of each cornea. At this time the conjunctival congestion was still intense though the discharge had become scanty.

From July 26 to July 30, the patient's temperature ranged from 99 to 102 F. From July 31 to August 7, the temperature ranged from 98.6 in the morning to 102 in the evening. Thereafter the patient remained afebrile. Examination in this interval revealed a normal prostate.

On the tenth day of hospitalization, a marked ciliary flush developed in the right eye. Numerous corneal precipitates and a plastic exudate in the pupillary area overlying the anterior lens capsule appeared shortly thereafter.

On the thirteenth day in the hospital cutaneous lesions began to appear. These were hemorrhagic vesicular lesions, the size of a pea; two occurred on the lateral aspect of the left ankle, two on the dorsum of the right ankle, one on the left buttock and one on the right lumbar region. The lesions were rapidly transformed into keratotic elevations which lasted for four weeks, peeling off like crusts and leaving pale scars.

By the fifteenth day of hospitalization the iritis of the right eye had become steadily more severe and a mild iritis had developed in the left eye. Thereafter, a continuous gradual improvement of the keratitis and iritis ensued with complete subsidence of all ocular conditions on Sept. 3, 1944. Therapy consisted only of hot compresses and instillations of atropine.

Approximately two months after hospitalization all symptoms had disappeared.

SUMMARY

A case of Reiter's disease is presented chiefly because of the severity of the ocular complications. The ophthalmologist should be aware of this syndrome, which resembles a gonorrheal infection closely but is not due to the gonococcus. While therapy is nonspecific, the ultimate prognosis for the eyes is good.

LOCAL TOXIC EFFECT OF DETERGENTS ON OCULAR STRUCTURES

IRVING H. LEOPOLD, M.D., D.Sc.
PHILADELPHIA

In recent years attention has been directed to the value of detergents in ophthalmology. Although they are being used as germicides and cleansing agents,[1] most of the ophthalmologic consideration has been devoted to their penetrant action, i. e., to their ability to aid in increasing the penetration of therapeutically active substances through the cornea. O'Brien and Swan [2] demonstrated that the intraocular penetration of carbaminoylcholine chloride could be enhanced by the use of 0.1 per cent zephiran chloride, 1 per cent saponin, 0.1 per cent Duponol PC or 0.1 per cent Aerosol OT. Other investigators followed this lead and showed that the intraocular penetration of other locally applied drugs could be increased by the use of detergents. Bellows and Gutmann [3] demonstrated the increased penetration of sulfonamide compounds when such detergents as Aerosol OS, Aerosol OT, Tergitols 4, 7 and 08, Ocenol KD (oleyl alcohol), sodium lauryl sulfate and zephiran chloride were used. Leopold and Scheie [4] studied the increased penetration of sulfathiazole from liquid and ointment vehicles using 0.1 per cent Duponol ME dry, and Leopold and Steele [5] observed the increased penetration of other sulfonamide drugs, using 0.1 per cent Duponol ME dry in eyes with normal, inflamed and abraded corneas. Boyd [6] established the increased penetration of physostigmine with the employment of zephiran in the vehicle.

It would seem advisable to consider the incorporation of these detergents in various ophthalmic preparations in an effort to increase the intraocular penetration of many locally applied therapeutic agents. However, before any medicinal agent can be recommended for local ocular use, its toxic properties must be determined. Maier [7] found little or no reaction from the daily application of zephiran chloride in concentrations of 1 : 4,000 to 1 : 2,500. He did notice defensive movements of the animal immediately after instillation. However, Maier washed out the zephiran with saline solution one minute after application. Swan [8] called attention to the local toxic effect of detergents, with particular reference to zephiran. He showed that minute concentrations of zephiran chloride as small as 0.025 per cent, resulted in a violent reaction in the rabbit eye when injected into the anterior chamber. Even more important was the development of conjunctival edema and desquamation when a single drop of a solution containing 0.1 per cent zephiran chloride was applied to the human cul-de-sac. After such a dose he also noted minute punctate gray areas, which tended to coalesce and form a gray haze in the corneal epithelium. Repeated instillations of zephiran chloride in a concentration as low as 0.03 per cent produced similar conjunctival and corneal changes. All changes, however, were reparable when application of the drug was stopped. Swan [8] also noted that the damage which followed local application of undiluted Aerosol OT was entirely superficial.

It has been shown that the bactericidal activity of standard antiseptics, such as chloramine-T, chloroazodin, merthiolate, and potassium permanganate, was enhanced when combined with wetting agents.[9]

Kintz [10] reported better results with sulfonamide compounds plus a detergent than with

From the Department of Ophthalmology, the School of Medicine of the University of Pennsylvania.

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1. Smith, C. S.: Some Recent Advances in Ophthalmology, J. Missouri M. A. **36**:72, 1939.

2. O'Brien, C. S., and Swan, K. C.: Carbominoylcholine Chloride in the Treatment of Glaucoma Simplex, Arch. Ophth. **27**:253 (Feb.) 1942.

3. Bellows, J. G., and Gutmann, M.: Application of Wetting Agents in Ophthalmology, Arch. Ophth. **30**: 352 (Sept.) 1943.

4. Leopold, I. H., and Scheie, H. G.: Studies with Microcrystalline Sulfathiazole, Arch. Ophth. **29**:811 (May) 1943.

5. Leopold, I. H., and Steele, W. H.: Unpublished observations.

6. Boyd, J. L.: Quantitative Comparison of Methods of Administering Physostigmine, Arch. Ophth. **30**:521 (Oct.) 1943.

7. Maier, E.: Preservation of Biological Fluids, J. Bact. **38**:33, 1939.

8. Swan, K. C.: The Reactivity of Ocular Tissues to Wetting Agents, Am. J. Ophth. **27**:1118, 1944.

9. Fischer, V. C.: Influence of Wetting Agents on Various Antiseptics, Am. J. Pub. Health **32**:389, 1942. Petroff, S. A., and Schain, P.: New Concentration and Staining Method for Demonstrating Acid-Fast Bacilli in Sputa and Other Tuberculous Matter, Quart. Bull., Sea View Hosp. **4**:145, 1939.

(Footnotes continued on next page)

sulfonamide solution alone against infected wounds of the soft tissues of the face. Robson and Scott [11] demonstrated that a solution of sodium sulfacetimide or of sodium sulfadiazine plus 0.1 per cent Duponol ME dry was more effective in clearing standard experimental infections of the cornea due to the streptococcus than either sulfonamide preparation without the detergent.

The local instillation of many drugs, such as the sulfonamide compounds, must be made several times each day for maximum effect. In many instances the eyes requiring therapy will be abraded or have infected ulcerations. Before recommending the incorporation of detergents in solution of a sulfonamide compound, it is necessary to determine the tolerance of eyes with corneal abrasions as well as of eyes with intact corneas, for the various detergents. That is the purpose of the present studies.

EXPERIMENTAL STUDY

METHODS AND MATERIAL

Normal Rabbit Eyes.—The detergents which were studies are listed in table 1. Each agent was studied in concentrations of 0.1, 0.25, 0.5, 1 and 100 per cent. Zephiran chloride was studied in 0.03 per cent concentration, as well as in the other concentrations. Isotonic solution of sodium chloride was used as the diluent. The p_H of the resultant solutions, as measured by a glass electrode, ranged from 6 to 7.5. The p_H of the aerosols varied from 6 to 7. The Tergitol, Duponol and zephiran preparations had a p_H of about 7. Normal rabbit eyes were used in the first group of tolerance experiments. All eyes were examined with the aid of a corneal biomicroscope. The following methods of application were employed: (1) single instillation of 2 drops of each concentration; (2) repeated instillation four times daily of each concentration except the undiluted strength.

TABLE 1.—*Synthetic Detergents Investigated* *

Aerosol OT	Dioctyl ester of sodium sulfosuccinate	American Cyanamid and Chemical Corporation
Aerosol OS	Isopropyl naphthalene sodium sulfonate	American Cyanamid and Chemical Corporation
Tergitols 4 and 7	Higher secondary alcohol sulfate	Carbide and Carbon Chemical Corporation
Tergitol 08	Synthetic primary alcohol sulfate	Carbide and Carbon Chemical Corporation
Zephiran	High molecular alkyl, dimethyl and benzyl ammonium chlorides	Alba Pharmaceutical Co., Inc.
Duponal ME dry	Higher aliphatic alcohol sulfates derived from technical lauryl alcohol and contains a minimum of electrolytes	E. I. du Pont de Nemours & Co., Inc.

* All the data in this table except those for Duponol, are derived from Bellows and Gutmann.[3]
All the detergents except zephiran are anionic, zephiran being cationic.

Tolerance of Eyes with Abraded Corneas.—Mechanical denudations 6 mm. in diameter were produced in the corneas of rabbit eyes by means of a trephine and plunger so arranged as to cut a constant depth. The epithelium was removed from the cut area by means of a swab dipped in collodion. Fluorescein was used as a guide to the depth and extent of staining. This method has been previously described.[12] Denudations were produced in this manner in both eyes of 84 chinchilla rabbits, weighing from 2 to 3 Kg. All of the detergents listed in table 1 were used. The concentrations used were 0.1 and 0.5 per cent of each of the following substances: Duponol ME dry, Aerosol OS and OT and Tergitols 4, 7 and 08. Zephiran chloride was used in concentrations of 0.1 and 0.3 per cent. Each solution to be tested was applied to the right eyes of 6 rabbits. The left eyes of the 6 rabbits received isotonic solution of sodium chloride and acted as controls. Instillations were made four times each twenty-four hours, at 9, 12, 3 and 6 o'clock. Each instillation consisted of 4 drops. Each eye was examined and stained with fluorescein daily. The results are listed in table 2. Instillations were made for three days.

TABLE 2.—*Influence of Detergents on Regeneration of Corneal Epithelium*

Concentration of Detergent Used	Number of Eyes Whose Corneal Epithelium Had Regenerated on Designated Days							
	2	3	4	5	6	7	8	9
Tergitol 4, 0.5%	..	..	1	..	..	3	2	..
Control	..	3	3	..	..	..	..	..
Tergitol 4, 0.1%	..	..	2	1	2	1	..	..
Control	..	3	2	1	..	..	..	..
Tergitol 7, 0.5%	..	..	2	1	1	2	..	..
Control	..	2	4	..	..	..	..	..
Tergitol 7, 0.1%	..	..	3	3	..	..	..	..
Control	..	3	3	..	..	..	..	..
Tergitol 08, 0.5%	..	..	4	..	2	..	..	..
Control	..	4	2	..	..	..	..	..
Tergitol 08, 0.1%	..	..	4	1	1	..	..	..
Control	..	3	2	1	..	..	..	..
Zephiran chloride, 0.1%	..	..	..	2	2	2	..	..
Control	..	3	3	..	..	..	..	..
Zephiran chloride, 0.03%	..	2	3	1	..	..	..	..
Control	..	5	1	0	..	..	..	..
Duponol ME dry, 0.5%	..	..	1	1	4	..	..	..
Control	..	4	2	..	..	..	..	..
Duponol ME dry, 0.1%	..	4	1	1	..	..	..	..
Control	..	5	1	0	..	..	..	..
Aerosol OS, 0.5%	..	..	..	1	..	1	4	..
Control	1	3	2	..	..	..	..	..
Aerosol OS, 0.1%	..	..	2	1	3	..	..	..
Control	..	3	3	..	..	..	..	..
Aerosol OT, 0.5%	..	..	..	..	..	2	2	2
Control	2	4	..	..	..	..	..	..
Aerosol OT, 0.1%	..	..	2	2	2	..	..	..
Control	1	2	3	..	..	..	..	..

RESULTS

Normal Eyes.—Single instillations of all detergents except zephiran chloride in concentra-

10. Kintz, F. P.: Traumatic Wounds of the Soft Tissues of the Face with a Preliminary Report on a New Azochloramid Solution and a New Sulfonamide Solution, Mil. Surgeon **89**:61, 1941.

11. Robson, J. M., and Scott, A. A. B.: Experimental Streptococcal Lesions of the Rabbit's Eye and Their Treatment, Brit. J. Exper. Path. **25**:81, 1944.

12. Leopold, I. H., and Steele, W. H.: Influence of Locally Applied Sulfonamides and Their Vehicles on Corneal Epithelial Regeneration, Arch. Ophth., to be published.

tions of 0.1 per cent failed to produce any signs of corneal involvement or conjunctival injection in the normal eyes. All agents produced marked blepharospasm in this concentration. In 0.1 per cent concentration zephiran chloride produced conjunctival hyperemia, edema, loosening of the conjunctival epithelium and minute areas of corneal staining. These changes disappeared entirely within twenty-four hours.

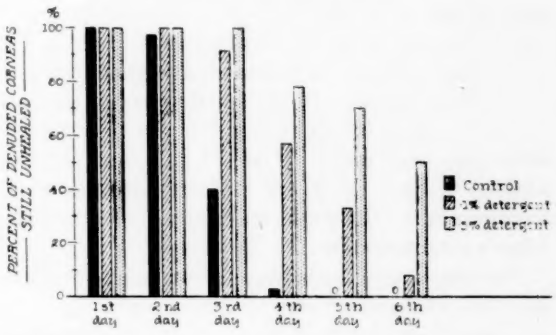
Single instillations of 0.25 per cent concentrations of all the detergents tried except zephiran chloride failed to produce any corneal changes but did create slight conjunctival hyperemia. The changes noted with zephiran chloride in 0.25 per cent concentration were similar to those with 0.1 per cent concentration and also disappeared within twenty-four hours. Single instillations of 0.5 per cent concentrations of all the detergents produced all the conjunctival changes noted with 0.1 per cent zephiran chloride. These disappeared in twenty-four hours. Of these substances, Tergitol 08 produced the least changes. Only zephiran produced corneal alterations. The 1 per cent concentrations of all the detergents except Tergitol 08 produced blepharospasm, conjunctival hyperemia, edema, loosening of conjunctival epithelium, superficial corneal haziness and areas of corneal staining. All these changes disappeared within twenty-four hours after single applications. Tergitol 08 produced less pronounced conjunctival changes than the others and no corneal changes.

Single applications of the undiluted Tergitols 4, 7 and 08, of the powder of Duponol ME dry and Aerosol OS and of the solid aerosol OT produced marked conjunctival injection, edema, considerable sloughing of the conjunctival epiepithelium and staining of one third of the cornea within the first few minutes. Superficial punctate areas and corneal haziness occurred in all eyes. These changes had disappeared from the majority of the eyes so treated by the end of one week. A few eyes showed a slight corneal haze, although there was no corneal staining at the end of two weeks. Although some eyes recovered more rapidly than others, one agent when used in this concentration did not produce consistently less damage than the others. At no time did biomicroscopic examination reveal any pathologic change in the iris, the lens or the anterior chamber.

Repeated applications four times daily of 0.1 and 0.25 per cent concentrations of Duponol, Aerosol OS and Aerosol OT and Tergitols 4, 7 and 08 created only mild conjunctival injection. However, after each instillation considerable blepharospasm occurred, which persisted for approximately four minutes. These conjunctival changes disappeared entirely within twenty-four hours after the instillations were discontinued.

Repeated use of 0.5 per cent concentrations of Duponol ME dry, Aerosol OT, Aerosol OS and Tergitols 4 and 7 produced pronounced conjunctival edema, sloughing of epithelium and hyperemia. A mucoid discharge also developed. Corneal staining and superficial haziness occurred. All eyes cleared within forty-eight hours after the therapy was stopped. Tergitol 08 did not produce these changes in this concentration after five days of such therapy. With all the other detergents these changes developed after twenty-four hours.

Repeated use of a 1 per cent concentration of each agent produced the same changes. These were more severe and did not fully disappear in all eyes until seventy-two hours had elapsed after cessation of therapy. Tergitol 08 produced the corneal changes in this concentration only after seven days of such treatment.



Influence of detergents on regeneration of the corneal epithelium.

The following detergents were used in the study in both 0.5 and 0.1 per cent concentration: tergitols, 4, 7 and 08; aerosols OS and OT, and Duponol ME dry. Zephiran chloride was used in 0.1 per cent concentration only.

There were 84 control eyes; 36 eyes were treated with the 0.5 per cent concentration and 42 eyes with the 0.1 per cent concentration.

Abraded Eyes.—Table 2 and the graph present the results of experiments on epithelial regeneration. It is evident from the data that all these agents retard regeneration of corneal epithelium when 0.5 per cent concentrations are used four times a day. The 0.1 per cent concentrations also retard regeneration of corneal epithelium, but not to such a degree as the 0.5 per cent preparations. Zephiran chloride retards regeneration of corneal epithelium slightly in concentrations as low as 0.03 per cent. In many of the abraded eyes receiving a 0.5 per cent concentration of the detergent four times a day, vascularization and edema of the cornea occurred.

A few became infected in spite of the bactericidal potentialities of the detergents. Scarring occurred in a few of the detergent-treated eyes but not in any of the control eyes.

COMMENT

It is evident that the detergents are capable of inflicting damage to normal rabbit eyes. Concentrations which are damaging vary with the detergent and with the frequency of application. The damage, as pointed out by Swan,[8] is entirely superficial even when an undiluted preparation of the detergent is used. The structures involved are the conjunctiva and the cornea. Conjunctival edema, mucoid discharge, sloughing of cells and injection are characteristic. Punctate haziness, and later general haziness and staining, of the cornea are found. These changes are similar to those described by Swan.[8] The tissue alterations noted in the normal rabbit eye are usually capable of recovering without permanent damage after contact with the detergent is ended. No change characteristic of an individual detergent was noted. All the detergents tested produced the same type of ocular damage.

All detergents used retarded regeneration of corneal epithelium. This retardation was marked when a solution containing 0.5 per cent of the detergent was used. The 0.1 per cent concentration of each detergent still retarded epithelial regeneration. although much less so than the higher concentration.

Various suggestions have been made to account for the cytotoxic effects of detergents.

Loeb,[13] in 1913, found that surface-active agents, among them bile salts and higher fatty acids, when applied to unfertilized eggs of the sea urchin, induced cleavage and development, whereas higher concentrations caused cytolysis. Mirsky [14] and Anson [15] suggested that the protein molecules of the cells may be disrupted by the pull of the detergents and thus denatured. Kuhn and Beilig [16] suggested that the germicidal concentrations of some detergents correspond rather closely with the concentration necessary to bring about denaturation of proteins. Baker, Harrison and Miller [17] showed that there is a fairly good correlation between the bactericidal action and the inhibition of bacterial metabolism. They were also able to demonstrate [18] that lecithin and cephalin could prevent this inhibition.

These studies do not contraindicate the use of detergents; they simply call attention to the toxic property of these compounds. These data would argue against universal incorporation of these agents in ophthalmic preparations. From these observations on their influence on rabbit eyes, one can say that detergents should not be recommended for repeated use in eyes with corneal abrasions. If they are used, the concentration should not be above 0.1 per cent for Duponol ME dry, Tergitol 08, Tergitol 4, Tergitol 7, Aerosol OS and Aerosol OT. Zephiran chloride could not be used in concentrations over 0.03 per cent. If detergents are used in eyes with an intact cornea, or wherever they are used, the patient should be warned to expect irritation and blepharospasm. All patients using local detergents in the eye, or ophthalmic preparations for local use containing detergents, should be examined at routine intervals to determine whether any local toxic effects of the detergent are appearing. Cessation of the use of the detergent will probably be followed by clearing of the superficial damage inflicted.

SUMMARY AND CONCLUSIONS

Repeated application of detergent solutions produced conjunctival damage in concentrations as low as 0.1 per cent. Zephiran chloride in this concentration produced corneal damage.

Repeated applications of higher concentrations of all the detergents tested produced superficial corneal changes in normal rabbit eyes.

Repeated applications of solutions containing 0.5 per cent of each detergent definitely retarded regeneration of corneal epithelium. The 0.1 per cent concentration slightly retarded the regeneration.

The changes produced in the conjunctiva and cornea by one application of undiluted preparations of several of the detergents are reparable.

The tissues subject to damage by the detergents are the conjunctiva and cornea. No evidence of involvement of deeper tissues of the cornea, the iris, the lens or the anterior chamber could be noted.

Local ophthalmic use of the detergents should be considered and recommended only with knowledge of their possible toxic properties.

Hospital of University of Pennsylvania.

13. Loeb, J.: Artificial Parthenogenesis and Fertilization, Chicago, University of Chicago Press, 1913.

14. Mirsky, A. E., in Cold Spring Harbor Symposia on Quantitative Biology, Cold Spring Harbor, L. I., The Biological Laboratory, 1938, vol. 6, p. 150.

15. Anson, M. L.: The Denaturation of Proteins by Synthetic Detergents and Bile Salts, J. Gen. Physiol. **23**:239, 1939.

16. Kuhn, R., and Beilig, H. J.: Ber. d. deutsch. chem. Gesellsch. **73**:1080, 1940.

17. Baker, Z.; Harrison, R. W., and Miller, B. F.: The Bactericidal Action of Synthetic Detergents, J. Exper. Med. **74**:611, 1941.

18. Baker, Z.; Harrison, W., and Miller, B. F.: Inhibition by Phospholipids of the Action of Synthetic Detergents on Bacteria, J. Exper. Med. **74**:621, 1941.

PLASTIC SURGICAL REPAIR ABOUT THE EYES WITH FREE GRAFTS

MAJOR ABRAHAM SCHULTZ AND LIEUTENANT CHARLES E. JAECKLE
MEDICAL CORPS, ARMY OF THE UNITED STATES

The surgical correction of scarred deformities about the eyes as the result of previous injuries assumes increasing importance to the military ophthalmologist as the war progresses. In their repair, special attention must constantly be given to the functional result of the eye, as well as to its cosmetic appearance. Because of his special knowledge of the physiology and anatomy of the eye and its adnexa, plastic surgical procedures about the eye are preferably performed by the properly trained ophthalmic surgeon.

In many instances, free grafts of skin or mucosa are most effective in accomplishing the desired result. This report cites 3 cases to illustrate the cosmetic and functional improvement about the eyes that can be obtained with use of various types of free grafts. It also serves to review and emphasize the important basic principle of these procedures as advocated by Wheeler and Hughes in the application of this form of plastic surgery.

FREE MUCOUS MEMBRANE GRAFTS

Severe symblepharon may produce deformity, loss of vision or mechanical irritation of the eye. Its basis is loss of substance and consequent defect in the conjunctiva, followed by adhesions of the raw surfaces. Prior to the use of free grafts, surgical measures for relief from symblepharon often consisted simply of division of the band, sometimes with the use of a form, with the hope that this would prevent the adhesion from reforming. This procedure was unsuccessful since it did not attack the cause of adhesions.

The correction of symblepharon in cases in which there is insufficient conjunctiva to permit mobilization and covering of all raw surfaces without obliterating any of the fornix depends on replacing the lost substances with a graft. In his book on "Reconstructive Surgery of the Eyelids," Hughes [1] reviews the types of tissue which have been employed to repair conjunctival defects. These include, in the order of their first use: skin, rabbit conjunctiva, mucous membrane from the mouth, human conjunctiva, autogenous vaginal mucosa, rectal mucosa, homogenous vaginal mucosa and homogenous amnion. Mucosa from the mouth, first used by von Carion in 1873, is now favored by most ophthalmic surgeons to repair defects of conjunctiva when the globe is present.

Autogenous buccal or labial mucosa grafts to the lids and globe take readily. The donor tissue is readily available and conveniently obtained, and the donor site requires little postoperative attention. It may be left unsutured. These advantages are of particular significance in military surgery. Unlike skin, mucous membrane provides a smooth surface and glands. It does not desquamate and has no hairs; therefore it does not produce corneal abrasion.

The technic of removal of the mucosa graft consists in raising a thin layer with superficial injection of procaine and dissecting with cataract knife or scissors. Any submucosal fat present on the graft is trimmed with scissors. The graft is promptly applied to the area of defect and sutured in place with fine silk sutures on atraumatic needles. When the graft is applied to the globe, it is desirable to fix it in place with episcleral sutures. This fixation has been emphasized by Gifford [2] and Castroviejo.[3] It is especially important at the limbus. Failure to do this may result in the graft growing over the cornea when tissue has been shaved from that structure, as in cases of recurrent pterygium.

CASE 1.—*Mucous membrane graft for symblepharon.*

G. M., a private aged 21, a member of a hospital medical detachment, was first seen in the eye clinic of Lovell General Hospital Feb. 2, 1943. He complained that for several months his right eye had been red, irritable and sensitive to light. This symptom was so severe on waking that he was unable to open the eye for thirty minutes or so, and then he squinted the lids of this eye most of the day.

He stated that at 9 years of age the right eye was burned with wet lime. Prompt treatment at an ophthalmic hospital saved the eye, but adhesions developed between the lids and the globe. Operation was subse-

From the Eye Section, Lovell General Hospital, Fort Devens, Mass.

1. Hughes, W. L.: Reconstructive Surgery of the Eyelids, St. Louis, C. V. Mosby Company, 1943.

2. Gifford, S. R.: Lectures on Ophthalmic Surgery, Postgraduate Course in Ophthalmology, Northwestern University, 1941.

3. Castroviejo, R.: Superficial Keratectomy, demonstrated by movies before the Washington, D. C., Ophthalmological Society, March 1944.

quently performed for this defect, but no permanent improvement was obtained. After the accident, the injured eye became "practically blind," and the upper lid drooped. This condition had persisted unchanged.

Examination revealed that vision in the right eye was limited to perception of hand movements; visual acuity in the left eye was 20/20. The right upper lid drooped notably, and its movement was partially limited. The normal fold in the skin of the upper lid was absent. The bulbar conjunctiva was moderately injected. The upper fornix was largely obliterated by three adhesions between the lid and the globe (fig. 1 *A*). The largest of these extended from the midtarsal region down over the cornea to about 1 mm. below its vertex, involving about 20 per cent of the corneal surface. The cornea presented an annular limbal opacity and numerous vascularized scars, of varying density, involving the anterior stroma and Bowman's membrane. The fundus was not visible. The results of examination of this eye were otherwise without significance. The left eye was normal.

Despite conservative medical treatment, the symptoms did not improve significantly during the ensuing year. It was thought that the symptoms were largely attributable to traction on the globe during movement.

Fig. 1 (case 1).—Appearance of the lids (*A*) before and (*B*) after plastic repair.

To free the globe from the lid and to correct the disfigurement, surgical intervention was considered indicated.

On Jan. 20, 1944, with local anesthesia, the scar was dissected from the cornea and sclera in one piece, without excising it. The bulbar conjunctiva on either side was incised a few millimeters from the limbus and dissection carried upward to form a fornix. All of this tissue was used to line the upper lid and to reconstruct the fornix. The large defect in the bulbar conjunctiva which resulted was repaired with a mucous membrane graft, 28 by 15 mm., obtained from the lower lip. This was held in place with episcleral, 000000, surgical silk placed around all its edges and with one suture in the center of the graft. A pressure dressing was applied, and both eyes were bandaged.

The eye operated on was first dressed four days later, and the fellow eye was thereafter left open. The sutures were removed over the period of from the sixth to the twelfth postoperative day, two or three sutures in the fornix being inaccessible before the twelfth day. The soldier returned to full duty on February 1. Since then there have been no symptoms. The conjunctival injection has cleared considerably. The ptosis is appreciably reduced, and the normal fold has appeared in the skin of the lid. The upper fornix is normal in depth (fig. 1 *B*). The globe and the lid move freely. The upper portion of the cornea, from which the adhesion was dissected, is now clearer than most of the rest of the cornea. The visual acuity is 20/300.

The relief of symptoms, the improvement of vision and the improvement of his appearance have had a salutary effect on this soldier's morale and have permitted him to perform his duties without the interruptions previously necessitated by visits to the clinic. As was pointed out by Spaeth,[4] mucous membrane grafts in the repair of such conditions may preserve "the possibility of future improvement in vision by keratoplasty."

FREE EPITHELIAL GRAFTS

This type of graft was first reported by Ollier in 1872 and modified by Thiersch in 1874 so that it is now generally known as the Ollier-Thiersch graft. It includes the epidermis and tops of the papillae of the corium and averages 0.01 inch (2.5 mm.) in thickness. It is preferably taken from the hairless surfaces of the inner thigh or arm with a large razor or with the Padgett dermatome. Because of its great availability and high probability of take, it may be used in repair of large traumatic defects or extensive granulation surfaces of the lids. Because of its thinness, however, the epithelial graft appears blanched and offers less protection than a full thickness graft.

One of the chief uses of the Ollier-Thiersch graft today is in epithelization of the eye socket. The procedure was first reported by Esser[5] in 1917. It was then further modified until it was perfected by Wheeler.[6] He stressed the following points to be observed in relining the orbit:

1. Wide excision of the scar tissue causing contracture of the eye socket.

2. Careful dissection of the scar tissue from the under surface of the lids, with especial care to avoid injury to the levator palpebrae muscle.

3. Reconstruction of fornices, with the incision extended to the lower orbital rim.

4. Use of a mold, carefully shaped to fit the orbit, about which the graft is wrapped with the raw surface outward.

5. Complete immobilization of the graft by application of a pressure bandage.

In taking the graft, the skin should be kept on the stretch and flat. The donor site is dressed with petrolatum gauze, and the first redressing is done on the fourth postoperative day. The

4. Spaeth, E. B.: The Use of Mucous Membrane Grafts in Ophthalmic Plastic Surgery, Am. J. Ophth. **20**:897-907, 1937.

5. Esser, J. F. S.: Studies in Plastic Surgery of the Face, Ann. Surg. **65**:297-315, 1917.

6. Wheeler, J. M.: Restoration of the Obliterated Eye Socket, Am. J. Ophth. **4**:481-488, 1921.

newly formed skin may be retaken after three to four weeks, if necessary, if a Padgett dermatome is used.

CASE 2.—*Thiersch graft of the orbit.*

W. E., a private aged 33, was admitted to Lovell General Hospital Feb. 26, 1943 for plastic repair of the right orbit. Enucleation of the patient's right eye had been performed thirteen years previously, after a penetrating wound resulting from the accidental explosion of his rifle while hunting. An artificial eye, however, could never be retained in the socket because of secondary scar tissue.

On admission the socket of the right eye was shallow and conspicuously scarred. Thick adhesions extended from the fundus to the lower lid and partially obliterated the inferior cul-de-sac. This prevented proper retention of any prosthesis. The left eye was normal, and visual acuity was 20/40, correctible to 20/20.

On March 2, 1943 the scar tissue which was obliterating the eye socket was excised, with local anesthesia. The dissection was continued to the periosteum of the inferior orbital rim, thus freeing the lower fornix. The resulting raw surface was then made smooth in preparation for the skin graft, and all bleeding was controlled. A lateral canthotomy was done to facilitate the introduction and withdrawal of a mold of dental wax. This mold was carefully shaped to fit the socket, so that accurate contact between the opposing surfaces of the recipient area and the mold was made. A Thiersch graft, about 2 by 3 inches (5 by 7.5 cm.) square, was cut from the inner surface of the right thigh with a Sheehan-Kilner knife. The epithelial graft was wrapped around the previously fashioned mold, with the raw surface outward, and inserted into the prepared bed of the socket, with the overlapping edges meeting at the palpebral fissure. The lids were then closed with three silk marginal mattress sutures. A pressure bandage was applied over the right orbit, and both eyes were kept covered eight days to insure complete immobilization of the graft. The lid sutures were removed on the tenth postoperative day, and the mold was removed. The epithelium was now adherent at all points of contact with the previous raw surface, and the lower fornix was well formed. All excess portions of the skin graft were trimmed and the desquamated material was removed from the socket daily by irrigation with a solution of boric acid. A temporary prosthesis was procured on the fifteenth postoperative day and was satisfactorily retained in the restored socket. The patient was then returned to duty. Subsequently, a larger, permanent prosthesis was obtained.

FREE FULL THICKNESS GRAFTS

The military surgeon will often be able to reduce the need for plastic procedures by proper technic in the initial repair of lacerations of the lids. This involves complete hemostasis, careful approximation of all wound lips and particular attention to the lid margin. The white line and the anterior and posterior borders of the lid margins should be precisely alined and sutured. The tongue and groove technic of Hughes [7] with intermarginal sutures or adhesions, is recommended. If the laceration is small, the intramarginal suture of Minsky [8] may suffice and is perhaps particularly useful for the average military surgeon.

The repair of defects of the skin of the lid was first accomplished with sliding flaps and pedicle grafts. The use of structures of one lid for the repair of the opposing lid was first advocated and instituted by Grandenigo in 1870. The first successful use of free, full thickness skin for a defect of the skin of the lid was made by Le Fort in 1872 in a case of ectropion. At the same time, he employed the all-important principle of partial closure of the lids to prevent postoperative contraction.

Full thickness skin has been obtained from various parts of the body, including chiefly the arm, the leg and the back of the ear. Use of the skin of the upper lid was first emphasized by Dantrelle and Tartois in 1918. This technic was perfected by Wheeler,[9] who stated that in the young adult a piece of skin 20 to 25 by 50 mm. might be removed from the upper lid without danger of lagophthalmos. Skin from the lower lid should not be used because of the danger of producing ectropion.

Skin from the lid is superior to skin from any other source. In contrast to other skin, it gives a good, if not perfect, match in all respects—hair, color, texture, thickness and flexibility. There is little subcutaneous tissue. The graft does not tend to contract. The donor site is closed without difficulty with a subcuticular suture and heals without scar, deformity or loss of function. When a defect cannot be satisfactorily repaired with a free, full thickness graft, a sliding or pedicle flap may sometimes be utilized. Such grafts, however, which are taken from the brow or the cheek, have the disadvantages of greater thickness of the skin, increased scarring at the edge of the graft and new scars in the donor area.

The free, full thickness graft is outlined on the donor lid with a knife and dissected with cataract knife or scissors, taking care not to include any deep tissue. It is important to avoid handling the tissue, especially with forceps. A few sutures, preferably one in each end, may be placed for traction. These same sutures are used to fix the graft in its new site. There it is placed in a bed which has been carefully prepared, all scar tissue having been removed and all bleeding stopped. Fine sutures are placed close to the edge. Intermarginal adhesions are employed to

7. Hughes,[1] pp. 90-91.

8. Minsky, H.: Surgical Repair of Recent Lid Lacerations: Intramarginal Splinting Suture, Surg., Gynec. & Obst. **75**:449-456, 1942.

9. Wheeler, J. M.: Correction of Cicatricial Ectropion by the Use of True Skin of Upper Lid, J. A. M. A. **77**:1628-1630 (Nov. 19) 1921.

splint the repaired lid and to keep it on the stretch after operation.

In the hands of some operators, free, full thickness grafts have not been highly successful. Padgett [10] referred repeatedly to failure of take of full thickness grafts, but he also mentioned the suitability of full thickness skin from the lid for repair of defects of the lid. The problem in the case of repair of the lids differs from that in general plastic procedures, in that full thickness skin from the lid is thin, the area to be grafted

Fig. 2 (case 3).—Appearance of the lids before plastic repair, with the eyes (*A*) open and (*B*) closed.

is relatively small and the base is less often a granulating surface, which is a less favorable base for full thickness grafts. Furthermore, the ophthalmologist, in his grafting, probably less often deals with patients suffering from dehydration, hypoproteinemia and avitaminosis.

In the case of skin from the lid, free, full thickness grafts usually take when utilized by operators who have followed the principles set down by Wheeler. He emphasized the importance of pressure dressing, providing close application and immobilization and preventing edema and exudate. A stent may be desirable. Sea sponge, if available, is useful in obtaining pressure but is not necessary. Wheeler did not change the first dressing for five to seven days. Subsequent dressings are made at intervals of two to five days. A rise in temperature, pain, odor and discharge at the edge of the dressing will permit the diagnosis of infection if it is present. The graft need not be disturbed by early and frequent dressings.

Case 3.—*Repair of defect of skin of lid.*

A. V., private first class, was admitted to Lovell General Hospital March 15, 1944, complaining of inability to close his right eye completely, associated with redness and discharge in that eye.

He stated that on Jan. 23, 1944 he sustained multiple lacerations about the face, when he was thrown through the windshield of an automobile involved in a collision. He had received prompt treatment at another hospital, including cutaneous sutures for lacerations of the right upper eyelid, the right eyebrow, the right cheek and the scalp.

On examination, the right upper lid was seen to be pulled up and away from the globe by a scar running from the junction of the medial one quarter and the lateral three quarters of the border of the lid to a point about 8 mm. above the eyebrow (fig. 2 *A*). The lid did not follow the eye on downward gaze. The borders of the upper and lower lids of the right eye did not meet from the middle of the lids to the medial canthus, when the eyes were closed (fig. 2 *B*). The exposed conjunctiva of the globe in this region was injected. The medial quarter of the border of the upper lid was slightly everted. An attempt to evert the upper lid showed that the medial end of the tarsus was fixed by the scar below the eyebrow. There was no limitation of motion of either eye.

On March 20, 1944 the scar tissue of the right upper lid was completely excised. To form adhesions to the lid, the lid margins at this site were denuded in two pairs of opposing areas and brought together by means of mattress sutures tied over rubber bolsters. The defect in the skin in the right upper lid was repaired with a free, full thickness graft, elliptic in shape and measuring 25 by 9 mm., taken from the left upper lid. The graft was sutured in place with closely spaced, fine, interrupted silk sutures on atraumatic needles. The surgical wound of the donor lid was closed with a subcuticular, running silk suture. Both eyes were dressed, and a pressure bandage was applied to the right eye.

The first dressing was done on the fifth day. The subcuticular suture was then removed from the left

Fig. 3 (case 3).—Appearance of the lids after plastic repair, with the eyes (*A*) open and (*B*) closed.

lid and the right eye only dressed. All sutures were removed from the right lid on the seventh day. A pressure dressing on the right eye was continued for eleven days. All dressings were discontinued on the sixteenth day. The intermarginal adhesions were left in place for two months and then severed.

At the time of this report, three months after operation, the lid is in good position, and the coloboma is absent (fig. 3 *A*); the lid follows the eye on downward gaze and meets well on closure (fig. 3 *B*).

10. Padgett, E. C.: Skin Grafting, Springfield, Ill., Charles C Thomas, Publisher, 1942, pp. 20, 25 and 85.

POSTERIOR PRINCIPAL PLANE OF THE OPTICAL SYSTEM OF THE EYE AND SIGNIFICANCE FOR REFRACTION

PROFESSOR E. TRON
Chair of Ophthalmology of the Navy Academy of Medicine
NAVAL MEDICAL ACADEMY, U. S. S. R.

Refraction in the eye is determined by the position of the posterior focus of the eye in relation to the retina, which, in turn, depends on the length of axis and on the value of separate elements in the refractive apparatus of the eye, namely, radiuses of curvature of the cornea and of the surfaces of the lens, depth of the anterior chamber and thickness of the lens. The results of my investigations, described in a number of papers,[1] have shown that the length of the axis, as well as the elements of the refractive apparatus, vary considerably and that this variability has a great, and sometimes decisive, significance for refraction, permitting one to evaluate properly a number of peculiarities associated with the anomalies of refraction. However, the length of axis and its significance for refraction are not the only factors determining refraction in the eye. The position of the principal plane of the optical system is also of great importance. Each optical system possesses a definite refractive power. But if one takes into consideration that the distance of the posterior focus of the eye is measured from the principal planes of the optical system, it is clear that the position of the posterior focus must depend not only on the refractive power of the system but on the position of the principal planes. For this reason, the position of the posterior focus in two optical systems possessing the same refractive power may be different, depending on the position of the principal planes. When applied to the optical system of the eye, this means that the position of the posterior focus depends both on the refractive power of the eye and on the position of the posterior principal plane of the visual optical system. The greater the distance between the cornea and the posterior principal plane of the eye, the more the posterior focus will be displaced backward, the refractive power of the optical system remaining the same; on the other hand, the smaller the distance between the cornea and the posterior principal plane, the more forward will be the posterior focus of the optical system. It follows that the position of the chief posterior focus in relation to the retina and consequently the refraction differ with the same length of axis and refractive power, depending on the position of the posterior principal plane of the optical system.

The aim of the present study was to determine whether or not the foregoing statements concerning the significance of the posterior principal plane of the eye in refraction are true. The verification was made with 275 eyes by measuring the refraction with the Tscherning ophthalmophakometer (refraction from + 10 to — 25 D.). The radius of corneal curvature was measured with the Javal ophthalmometer. The radiuses of curvature of the surfaces of the lens, the depth of the anterior chamber and the thickness of the lens were measured with the Tscherning ophthalmophakometer. The position of the posterior focus and the length of axis were calculated on the basis of the data obtained from these determinations after refraction under atropine cycloplegia. Measurements of 130 eyes were taken by my associates and me, and values for 145 eyes were obtained from the works of Averbakh [2] and Zeeman.[3] I used the same material in a number of my earlier investigations.

The first problem to be investigated is the variability of the position of the posterior principal plane of the optical system. It is well known that Gullstrand calculated for his schematic eye a distance of 1.602 mm. between the principal posterior plane and the cornea. Our data are given in table 1.

As can be seen from this table, the position of the posterior principal plane in the optical system of the eye varies widely, within the limits of 1.06 and 2.51 mm. Its average distance from the cornea is 1.63 mm. Thus, our average value co-

1. Tron, E.: Optical Bases of Ametropia, in Special Collection on Ophthalmology in Honor of Forty Years of Scientific Activity of M. I. Averbakh, Moscow, Gosudarstvennoe izdatelstvo biologischeskoy i meditsinskoy literature, 1935; Optic Foundations of Aniso- and Isometropia, Sovet. vestnik oftal. **6**:481-499, 1935.

2. Averbakh, M. I.: Dioptrics of Eyes with Various Refraction, Inaug. Dissert., Moscow, 1900.

3. Zeeman, W. P. C.: Ein Beitrag zur Frage der optischen Grundlagen der Aniso- und Isometropie, Arch. f. Ophth. **133**:211-230, 1935.

incides with the position of the posterior principal plane in Gullstrand's schematic eye. However, significant deviations from this average value in either direction have been recorded. Values of 1.40 to 1.90 mm. have been frequently encountered, namely, in 232 eyes (84.5 per cent).

It is seen from the literature that investigations were carried out sixty-five years ago the results of which permitted the conclusion that the position of the posterior principal plane in the optical system of the eye is subject to considerable variations. After Helmholtz had suggested his ophthalmometer, a number of investigators were for many years engaged in measurements of elements of the visual apparatus of the eye. The difficulty of the method and the complexity and minuteness of the calculations restricted the number of examined eyes with various refractions to 56, among which 31 eyes had refractions from + 5.5 to — 13.0 D. (measured by von Reuss [4]). The table shows that in 31 cases the position of the posterior principal plane of the optical system presented variations from 1.39 to 2.33 mm. However, von Reuss, citing these data, among other results of his measurements, did not emphasize the considerable variability in the position of the principal posterior plane as seen from these values and did not discuss the finding. The literature devoted to the investigation of the optical elements of the eye does not contain much on this subject, and the problem remains unsolved.

TABLE 1.—*Position of Posterior Principal Plane in 275 Eyes with Refraction from + 10.0 to — 25.0 D.*

Position of Posterior Principal Plane, Mm.	Number of Cases
1.00 to 1.09	1
1.10 to 1.19	1
1.20 to 1.29	6
1.30 to 1.39	17
1.40 to 1.49	48
1.50 to 1.59	52
1.60 to 1.69	62
1.70 to 1.79	58
1.80 to 1.89	22
1.90 to 1.99	9
2.00 to 2.09	5
2.10 to 2.19	2
2.20 to 2.29	..
2.30 to 2.39	..
2.40 to 2.49	1
2.50 to 2.59	1

In order to determine factors influencing the position of the posterior principal plane in the eye, we studied the correlation between this position and other elements of the optical visual apparatus. For this, we calculated the coefficient of correlation between the aforementioned elements. In estimating the data obtained, one must take into consideration variations of the coefficient of correlation from 0 to 1. A coefficient of correlation equal to 0 indicates that no quantitative interdependence exists between the two given values. A coefficient of correlation equal to 1 indicates a maximum possibility of interdependence between the two values. The correlation may be of two kinds, positive or negative. A positive correlation means a simultaneous increase of both values. A negative correlation means a converse process; that is, an increase of one value is accompanied with a decrease of the other. The error in the coefficient of correlation was also calculated in each individual case. This was done in order to establish the extent of accuracy of the coefficient. According to the rules of variation statistics, the coefficient of correlation is considered accurate only if the error is not more than one-third the value of the coefficient.

The coefficients of correlation obtained are given in table 2.

As may be seen in table 2, the coefficients of correlation show no interdependence between the posterior principal plane and the length of axis because there is only insignificant and inaccurate correlation between these two values (coefficient of correlation = 0.09, which is equal to the error ± 0.08). This differs from the positive, and quite accurate, correlation between the position of the posterior principal plane and the refractive power of the eye (coefficient of correlation, 0.54 ± 0.06) and shows that the greater the refractive power of the eye, the farther the posterior principal plane is situated from the cornea. The refractive power of the eye is composed of two essential elements: the refractive power of the cornea and the refractive power of the lens. The refractive power of the cornea has no effect on the position of the posterior principal

TABLE 2.—*Correlation Between Posterior Principal Plane and Some Optical Elements of Visual Apparatus*

Elements in Regard to Which the Coefficient of Correlation Was Calculated	Coefficient of Correlation
Length of axis	0.09±0.08
Refractive power of eye	0.54±0.06
Refractive power of cornea	—0.002±0.08
Refractive power of lens	0.63±0.05

4. von Reuss, A.: Untersuchungen über die optischen Constanten ametropischer Augen, Arch. f. Ophth. **23** (pt. 4):183-268, 1877; Ophthalmometrische Mittheilungen 2: Messung eines atropinisirten hypermetropischen Auges, ibid. **26** (pt. 3):7-11, 1880.

plane if the corresponding coefficient of correlation approaches 0 (0.02). It is quite different with the lens. A considerable, positive and quite accurate correlation (coefficient of correlation 0.63 ± 0.05) between the position of the posterior principal plane and the refractive power of the lens indicates that the greater the refractive power of the lens the farther the posterior principal plane is situated from the cornea.

The foregoing data on factors determining various positions of the posterior principal plane in the optical visual system lead to the conclusion that changes in the position of the posterior principal plane in the eye are dependent on the value of the refractive power of the lens and that variations in this refractive power are most important.

TABLE 3.—*Position of Posterior Principal Plane in Eyes with Various Refractive Errors*

Material	Number of Eyes	Extreme Variants, Mm.	Average Value, Mm.	Mean Square Deviation
All eyes	275	1.06 — 2.51	1.63 ± 0.01	$\pm 0.20 \pm 0.01$
Emmetropia	60	1.30 — 2.51	1.69 ± 0.03	$\pm 0.23 \pm 0.02$
Ametropia	215	1.06 — 2.18	1.61 ± 0.01	$\pm 0.81 \pm 0.01$
Hypermetropia	95	1.07 — 2.06	1.62 ± 0.02	$\pm 0.18 \pm 0.01$
Myopia	120	1.13 — 2.18	1.60 ± 0.02	$\pm 0.18 \pm 0.01$

The position of the posterior principal plane of the optical visual system with various kinds of refractive anomalies is given in table 3.

As may be seen from table 3, the position of the posterior principal plane with various refractive conditions is the same. It is to be emphasized, however, that not only are the average values the same but the variability in the position of the posterior principal plane does not change if the mean square deviation is considered as the index of this variability.

Since the position of the posterior principal plane is subject to considerable changes, the question arises concerning the significance of this variability for ocular refraction. In the beginning of this paper, I suggested the hypothesis that, the length of axis and the refractive power of the eye being the same, the position of the posterior principal plane in relation to the retina, and consequently the refraction, should differ, depending on the position of the posterior principal plane. My associates and I carried out a detailed examination of 275 eyes, and in numbers of instances this hypothesis proved true. In the 4 cases in table 4 ametropia was produced by the position of the posterior principal plane.

In each of the 4 cases listed in table 4, two eyes are concerned: one emmetropic and the other myopic. The refractive power and the length of axis are the same. The only difference is in the position of the posterior principal plane, the latter causing ametropia in these cases. Certain facts prove that this is really true: Namely, in each of these cases the posterior principal plane has displaced farther forward in the myopic eye than in the emmetropic one. This forward displacement of the posterior principal plane, the value for refractive power and the constant length of axis are the reasons that the principal focus is not situated on the retina but is in front of it, thus causing myopia. Consequently, the greater the difference in the position of the posterior principal plane, the greater the degree of myopia. Thus, myopia of 1.0 D. (cases 1 and 2) corresponds to a difference in the position of the posterior principal plane of 0.39 and 0.36 mm., and myopia of 3.0 D. (cases 3 and 4), to a difference of 0.88 and 0.92 mm. respectively. It is to be noted, in addition, that difference in the position of the posterior principal plane corresponds to the degree of myopia. Forward displacement of the posterior principal plane influences refraction in the same way as increased length of axis. A change of 1 mm. in the length of axis causes an average change of refraction of 3.0 D. These figures are in complete conformity with data obtained in my 4 cases concerning the relation between the degree of myopia and the position of the posterior principal plane.

TABLE 4.—*Ametropia Produced by Position of Posterior Principal Plane*

Case Number	Change in Refraction, D	Length of Axis, Mm.	Refractive Power of Eye, Mm.	Principal Posterior Plane, Mm.
1	— 1.0	23.42	62.20	1.59
	Emmetropia	23.49	62.10	1.98
2	— 1.0	23.30	62.23	1.48
	Emmetropia	23.38	62.02	1.84
3	— 3.0	24.27	61.81	1.55
	Emmetropia	24.26	61.19	2.43
4	— 3.0	25.06	59.03	1.22
	Emmetropia	25.09	58.21	2.14

To what group of refractive anomalies should ametropia caused by various positions of the posterior principal plane belong? The answer is based on the classification of anomalies of refraction which I suggested in one of my earlier studies on refraction.[1]

All the spherical anomalies of refraction may be divided in four groups. This classification is based on changes in optical elements in 60 em-

metropic eyes, established by means of ophthalmophakometric measurements.

1. Axial ametropia: refractive power of the eye within the limits for emmetropic eyes; rather considerable values for length of axis, as observed with emmetropia.

2. Refractive ametropia: length of axis within values observed in emmetropic eyes; rather considerable values of refractive power, as observed with emmetropia.

3. Mixed ametropia: length of axis and refractive power greater or less than values observed in emmetropic eyes.

4. Combination ametropia: values for length of axis and for refractive power not beyond values obtained for emmetropic eyes, but their interrelation differing from that observed in normal eyes.

Ophthalmophakometric measurements on 60 emmetropic eyes showed that the refractive power of emmetropic eyes varies from 52.59 to 64.12 mm., and the length of axis, from 22.42 to 27.30 mm. It is obvious that the cases of ametropia belong to neither of these groups of anomalies. They seem to be closer to the group of combination ametropias because in this type refractive power and length of axis remain within the values observed in emmetropic eyes.

However, these cases of ametropia differ from combination ametropia in the following features: Length of axis and refractive power in ametropia are similar to those in emmetropia but interrelations of these optical elements are different. In ametropia due to the position of the posterior principal plane, values for the length of axis and for refractive power are not only within the limits of those occurring in emmetropia, but the interrelations of these optical elements are also identical in the two conditions. In these cases, ametropia is caused by the position of the posterior principal plane. Thus these cases present a new kind of ametropia. The difference between this new kind of ametropia and combination ametropia is explained in table 5, in which cases of combination ametropia and cases of ametropia induced by the position of the posterior principal plane are compared.

Variation in the position of the posterior principal plane can cause not only ametropia but various degrees of refractive anomalies. Our material contains 8 illustrative cases. Data given in table 4 show that differences in refraction produced by the position of the posterior principal plane never exceeds 3.0 D. The fact that ametropia induced by the position of the posterior principal plane reaches but a small value can be explained by the insignificant variation of the posterior principal plane (1.06 to 2.51 mm.). Much greater is the variation in refractive power and length of axis. As seen from the results of my investigations, the values for refractive power based on data obtained by measurement of 275 eyes varied from 52.59 to 66.88 mm., and values for length of axis, from 20.75 to 38.08 mm. We have noted that values for ametropia belonging to other groups reached higher degrees. Thus, axial ametropia reached + 10.0 D. in cases of hypermetropia and — 25.0 D. in cases of myopia; refractive ametropia reached — 13.0 D.; mixed ametropia, + 2.5 D. in cases of hypermetropia and — 15.0 D. in cases of myopia, and, finally, combination ametropia reached + 5.0 in cases of hypermetropia and — 10.0 D. in cases of myopia.

After we had established the significance of variability of the position of the posterior principal plane for refraction, it was necessary to consider anisometropia and isometropia from this point of view.

TABLE 5.—*Combination Ametropia and Ametropia Caused by Position of Posterior Principal Plane*

	No.	Change in Refraction	Length of Axis, Mm.	Refractive Power of Eyes, Mm.	Position of Posterior Principal Plane, Mm.
Combination ametropia	1	+ 4.0	23.52	56.77	1.54
		Emmetropia	23.50	60.76	1.57
		Emmetropia	25.02	56.81	1.50
	2	— 3.0	24.27	61.81	1.55
		Emmetropia	24.29	58.61	1.49
		Emmetropia	23.46	61.50	1.74
Ametropia caused by position of principal posterior plane	3	— 1.0	23.42	62.20	1.59
		Emmetropia	23.49	62.10	1.98
	4	— 3.0	24.27	61.81	1.55
		Emmetropia	24.26	61.19	2.43

Our material contained 22 cases of anisometropia, with a difference in the refractive power of the two eyes of from 2.0 to 13.0 D. I established the optical basis of anisometropia in one of my earlier works by considering the condition of the visual apparatus in these cases. Anisometropia can be divided in three types: (1) axial anisometropia, a difference in the refraction of the two eyes caused by a difference in the length of axis; (2) refractive anisometropia, a difference in refraction of the two eyes caused by a difference in refractive power, and (3) anisometropia of mixed origin, a difference in refraction of the two eyes caused by differences in the length of axis and in refractive power.

From the point of view of the position of the posterior principal plane in the two eyes, all the cases of anisometropia can be divided in

three groups: (1) Insignificant difference in the position of the posterior principal plane, of less than 0.1 mm.; (2) middle value of difference in position of the posterior principal plane, from 0.1 to 0.5 mm.; (3) difference in position of the posterior principal plane considerably greater than 0.5 mm. The respective degrees of anisometropia in these groups are as follows: group 1, from 2.0 to 7.5 mm.; group 2, from 2.0 to 13.0 mm.; group 3, from 2.0 to 4.5 mm. Consequently, high and low degree of anisometropia may be encountered with considerable, as well as with insignificant, differences in the position of the posterior principal plane in the two eyes. Therefore, the difference in the position of the posterior principal plane is of no importance in the genesis of anisometropia.

In 7 cases of isometropia, changes in the position of the posterior principal plane in the two eyes were insignificant. They vary from 0.04 to 0.25 mm., and only in 1 of these cases was the difference greater than 0.2 mm.

CONCLUSIONS

1. The position of the posterior principal plane in the optical visual system is subject to great variation. In 275 eyes with refractive power of from + 10.0 to — 25.0 D., it changed within the limits of 1.06 to 2.51 mm., an average value of 1.63 mm.

2. The position of the posterior principal plane is the same with various types of refraction.

3. A positive correlation occurs between the position of the posterior principal plane and the refractive power of the eye and of the lens. The greater the refractive power of the eye and of the lens, the farther the posterior principal plane is situated from the cornea. The coefficient of correlation between the position of the posterior principal plane and the refractive power of the eye is + 0.54. The length of axis has no effect on the position of the posterior principal plane.

4. A special kind of ametropia is to be noted, in which a refractive anomaly is caused by the position of the posterior principal plane in the optical vision system. This kind of refractive anomaly is seldom encountered, only 4 cases out of 215, or 1.85 per cent, being encountered. Ametropia caused by the position of the posterior principal plane reaches only a slight degree (3.0); the relatively small variability of the posterior principal plane accounts for this fact.

5. The position of the posterior principal plane may be the cause not only of ametropia but of a difference in the degree of refractive anomalies, without reaching any considerable value owing to the same cause.

6. Changes in the position of the posterior principal plane are of no importance whatever for the genesis of anisometropia.

7. Changes in the position of the posterior principal planes in both eyes are inconsiderable in isometropia.

Clinical Notes

MARFAN'S SYNDROME WITH UNUSUAL COMPLICATIONS

Report of a Case

JAMES L. MCGRAW, M.D., NEW YORK

Since Marfan, in 1896, first described the case of a young girl with the symptom complex of arachnodactyly and ectopia lentis, there has appeared in the literature a sufficient number of similar cases so that this syndrome can no longer be placed among the rare diseases. The reported number of typical and atypical cases is now well above 200.

The present case is a typical instance of Marfan's syndrome, with some unusual complications.

The patient is the sixth child of normal, healthy parents and grandparents. The first child, a boy, died at the age of 6 years in a home for mentally deficient children. He was mentally defective, and was subject to convulsive seizures. He was said to have an enlarged thymus gland. There was no known ocular disease. The second child, a boy, died at the age of 15 months, after a renal infection. This child was believed to have been normal in all respects. The third and fourth children are normal, healthy girls, aged 17 and 14 years. The fifth child, a girl, died at the age of 6½ years. This child was mentally retarded and had ectopia lentis and a double ninth rib on the right side. The child died, of unknown cause, in a school for mentally deficient children. The sixth child, the subject of this report, is a 6 year old girl, born at term after a normal, spontaneous delivery, prior to which the mother had an uneventful gestation. The child's development was slow. She spoke a few monosyllables at 15 months but did not talk until she was 3½ years of age. She stood at 16 months and walked at 2 years. The gait was always clumsy, and there appeared to be exaggeration of associated movements. The child was too retarded mentally to attend school. The parents noticed that vision had never been good, as the child was unable to recognize people or objects unless within very close range. A few weeks before the child's admission to the hospital the mother first noted what she described as a bubble or a drop of oil in the pupil of the right eye, which was present only at irregular times.

Examination revealed a tall, thin girl, with an apathetic, pained expression. She was 48 inches (121 cm.) tall and weighed 46 pounds (20.9 Kg.). The findings on general physical examination were essentially without significance except for prominent ears; a long, thin, flat chest; winging of the scapulas; slight curvature of the spine, and abnormally long, spider-like hands and feet. The ophthalmic examination was difficult because of the patient's inability to cooperate. Visual acuity was not determined. The anterior chamber of the right eye was very deep, the pupil irregular and the iris tremulous. The lens was completely dislocated into the vitreous and was seen lying inferiorly. At irregular intervals the lens spontaneously luxated into the anterior chamber for short periods of time and then moved back into the vitreous. The results of examination of the fundus and estimation of tension with the fingers were normal. The anterior chamber of the left eye was shallow, the pupil small and eccentric and the lens partially subluxated downward and inward. Tension seemed elevated on palpation, and the fundus was not well seen. The pupils responded poorly to mydriatics. With the patient under general anesthesia, the tension in the right eye with the lens at the time in the anterior chamber was 23 mm. and that in the left eye was 45 mm. of mercury, as measured with the Schiøtz tonometer. An attempt was made to keep the lens of the right eye trapped in the anterior chamber by constricting the iris behind it with miotics, as an aid in the extraction of the lens. However, after section the pupil dilated; the lens dropped into the vitreous, and a complete iridectomy and loop extraction were done. After operation, the temporal pillar of the iris became incarcerated in the wound but did not prolapse. The postoperative course was otherwise uneventful.

Three weeks later, the lens of the left eye was removed by loop extraction after complete iridectomy. The postoperative course in this eye was uneventful. The lenses removed from both eyes were almost completely spherical.

After operation, retinoscopic examination revealed a refractive error of + 9.00 sph. bilaterally and glasses were prescribed, which gave vision of approximately 20/70 in each eye. The tension in both eyes was normal to palpation, and the fundi were seen to be normal.

Seven months after extraction of the lens of the right eye, a cyst developed in the anterior chamber on the temporal pillar of the iris. The cyst grew rapidly and within one month half filled the anterior chamber and caused a rise in tension in the eye to 40 mm. of mercury (Schiøtz). The tension in the left eye was 23 mm. The child was readmitted to the hospital, and a needle was introduced into the cyst at the limbus. The fluid content of the cyst was evacuated and the cyst flushed several times with a 3.5 per cent solution of iodine. The iodine was withdrawn; the cyst collapsed, and the needle was removed. The eye remained slightly irritable for about two weeks after this procedure, but since that time has been white and quiet and the tension normal to palpation. Although suffi-

Read at a meeting of the New York Academy of Medicine, Section of Ophthalmology, April 16, 1945.

cient time has not elapsed to permit a report on the final outcome, there has been no evidence of recurrence of the cyst after six weeks.

The salient features in this case are as follows:

1. This case is a typical instance of Marfan's syndrome, occurring in a family in which 3 of 6 children were mentally deficient, and 1 of the 3 showed other congenital defects including ectopia lentis. In this case the usual features of arachnodactyly were present—ectopia lentis; apathetic expression; prominent ears; thin, flat chest; winging of the scapulas, and spinal curvature.

2. The tension was elevated in the eye with partial dislocation of the lens but not in the eye with complete dislocation despite the presence of the lens in the anterior chamber at times.

3. A cyst developed in the anterior chamber of the right eye seven months after extraction of the lens, causing a rise in tension in that eye.

4. The method chosen for treatment of the cyst in the anterior chamber was ablation with iodine. The treatment was well tolerated and to date appears to have been successful.

635 West One Hundred and Sixty-Fifth Street.

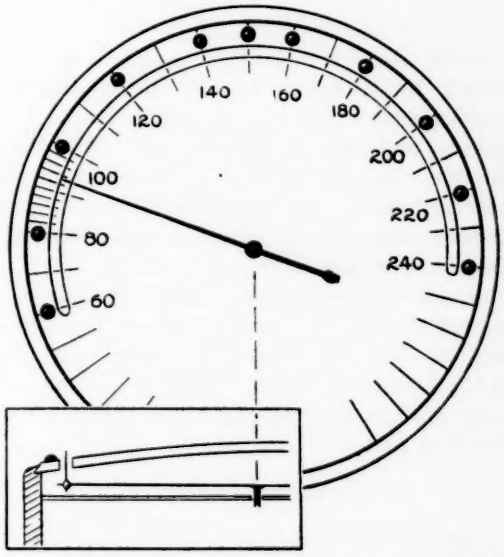
MODIFICATION OF A BLOOD PRESSURE APPARATUS FOR USE BY THE BLIND

O. H. Perry Pepper, M.D., Philadelphia

Recording the blood pressure is one of the steps in physical examination which is impossible for the blind physician with any of the usual types of sphygmomanometer. By a simple modification of the Tycos spring sphygmomanometer the procedure becomes easy after a little practice, with a range of error not exceeding 10 mm. of mercury.

All that is necessary to make it possible for a blind physician to read the gage is to cement a plastic fiber bristle at right angles to the outer third of the needle in such fashion that the tip of the bristle projects about one sixteenth of an inch (0.16 cm.) through a narrow slit cut through the plastic crystal covering the dial. The slit is circular in course and extends throughout the range of the scale. Small braille dots are attached to the crystal at points corresponding to the numbers of the scale; larger dots can be placed to correspond with readings of 100, 150 and 200 to orient the examiner's finger. (See illustration.)

This device was developed by J. O. Kleber of the American Foundation for the Blind as a result of a request to this Foundation. The apparatus has been used with success within its margin of error by the blind physician for whom it was devised. It is true that there are not many blind physicians in practice, but unfortunately there may be more as a result of war injuries. It seems proper, therefore, to draw this device to the attention of the medical profession and to state that Mr. Kleber believes the use of this type of modification could be adapted to other gages and meters, enabling blind persons to read them by touch. The thanks of the medical profession are certainly due to Mr. Kleber for his interest and help.



Blood pressure apparatus for use by the blind.

HERPES ZOSTER OPHTHALMICUS

REPORT OF CASES AND REVIEW OF LITERATURE

AMBROSE EARL EDGERTON, M.D.
SAN FRANCISCO

(Concluded from page 62)

EPIDEMIC AND SYMPTOMATIC TYPES

Two main types of herpes zoster can be differentiated: the epidemic type, sometimes called primary, specific, idiopathic or true herpes zoster, and the symptomatic type, often called a secondary, nonspecific or zosteriform eruption. The last term was suggested by Darier in 1923, and by Teague, Goodpasture and Lipschütz, in 1924.

EPIDEMIC TYPE

True zoster is contagious and bears a resemblance to varicella, encephalitis and anterior poliomyelitis. An attack usually conveys immunity, and, like other exanthems, recurrence is unusual. It presents many symptoms commonly observed with eruptive febrile diseases, such as malaise, digestive disturbances and fever, which usually subside with the appearance of the eruption. True zoster runs a definite course, is not related to other disease and often appears in epidemics. Von Hoffmann, in 1879, reported one of the first epidemics of ophthalmic zoster, of 24 cases with ocular complications, during an epidemic of zoster.

SYMPTOMATIC TYPE

The symptomatic type of herpes zoster is associated with various diseases or complications of other disorders or may follow trauma or intoxication. Symptomatic zoster has a very different history from that of the epidemic type. The eruption is due not to a virus but to secondary involvement of the nerve or posterior root ganglion in the course of other disease. This eruption is unaccompanied with fever, runs a chronic course, subsides and may recur, depending on the cause. The eruption clears rapidly, without deep scarring and pigmentation, and is preceded by severe pain for several days, or even weeks. The histologic changes are the same as those in true zoster—small round cell infiltrations, hemorrhagic extravasation, destruction of ganglion cells and inflammation of nerve sheaths. At the onset the symptoms are frequently the same as those of true zoster as far as the ophthalmic form is concerned. The evolution and termination are variable.

In the literature, symptomatic zoster is attributed to the most diverse etiologic factors, ranging from acute infection to various kinds of trauma, errors of refraction and even severe mental strain and emotion. Besnier related the case of a student in whom the disease developed while he was studying a case. Among etiologic factors are syphilis, tuberculosis, acute or chronic infections, metabolic diseases, chronic poisoning, multiple sclerosis, malaria, leukemia, degenerative processes, atmospheric conditions, exposure to wind and rain, subarachnoid hemorrhage and trauma. Numerous cases have been reported in which the eruption followed lesions of the orbit, pontile tumors, fracture of the base of the skull or spine, extraction of teeth, cataract operations, retrogasserian neurotomy and various kinds of wounds.

The symptomatic type is associated with toxic, inflammatory or neoplastic damage involving the fifth nerve, the gasserian ganglion or fibers that constitute the central connections of the nerve. Cases have been reported in which the causative factor was arsenic, mercury, bismuth, iodides or carbon dioxide poisoning, and the disease has followed pneumonia, meningitis, influenza, diabetes and gout. In many cases the condition bears a distinct relation to diseases of the general nervous system and degenerative processes.

The process may extend to the fibers of the posterior root and may extend into the gray matter, affecting chiefly the posterior horn; the anterior horns may also be involved. Duke-Elder stated that some of the lesions which develop may be due to the primary central lesion, and not to involvement of the ganglion, and that the primary cause may be latent at the time of

the eruption and the secondary nature of the zoster may be diagnosed some time after it has subsided.

Symptomatic zoster is likely to occur when the first sensory neuron is damaged. Once the virus has entered the sensory neuron, it proceeds peripherally toward the skin and centrally toward the neuraxis. R. T. Brain suggested that the susceptibility of the first sensory neuron in adults may be due to its possessing a tissue immunity more feeble than that of other parts of the body or to its immunity being lowered by a preceding lesion.

Chronic inflammatory disease predisposes to herpes zoster. This process within an internal organ has been explained by van der Scheer, in 1913, and by Nyáry, in 1921, who in his summary stated that a morbid process within an internal organ irritates centripetal sympathetic fibers. The irritation is transmitted by way of the ramus communicans of the sympathetic trunk to a spinal ganglion. If such centripetal irritation is of sufficient intensity, it may go on to the cerebrum and cause pain. If not of sufficient intensity, a state of irritability persists in the ganglion, which may spread to other centripetal sensory fibers from the skin, thus producing hyperalgesia of Head's area. Such a prolonged state of irritability of a spinal ganglion produces physiochemical changes within the ganglion cells and sets up a local predisposition to infection with the herpes zoster virus or with other pathogenic organisms.

ETIOLOGIC FACTORS

INJURY

Injury probably serves as an exciting factor. Many cases have been reported in which the infection developed in the region which had suffered the injury, with or without a lesion of the skin. The eruption developed soon or in the course of a few weeks.

Many investigators attribute zoster to a virus which first affects the skin and then, by an ascending process, reaches the nervous system. They believe that the trauma acts by diminishing locally the resistance of the organism to a zoster virus, preexistent in the region, and thus its resistance to a virus which it normally harbors is reduced. In many cases in the literature the cause is given as an injury to the head or eyelid, as described by Höfer, Terrien, Hildesheimer, Gauchard and Bernard, and Flemming. Charcot, as early as 1859, published his account of a case of recurring herpes zoster following a gunshot wound. Herpes zoster has followed peripheral nerve trauma, as reported by Moore, Knowles, Kinnicutt, Coursserant, de Salterain, Duméry, Terrien and Bayer, and central trauma, as reported by Gunn. Zoster has followed surgical operations on the trigeminus for neuralgia, due to injury of the dorsal root ganglions. Also, infiltration of the ganglions by tumor or by a leukemic process has caused the eruption. Apparently, anything which may bring about an irritable or inflamed gasserian ganglion, spinal ganglion, nerve tract or peripheral branches may be responsible for the eruption. Knowles stated, however, that in cases of traumatic origin the ganglions are not involved but the peripheral nerves alone are the seat of the pathologic changes. Caspar, in 1906, cited a case of herpes zoster ophthalmicus in a youth of 18 years in which the eruption developed four days after a tattooing operation on the cornea. Schiffer reported a case of ophthalmic zoster in a patient with a melanotic sarcoma of the sphenoid bone. In this case the oculomotor paralysis preceded the eruption by several weeks. Landis described a case in a man, with chronic frontal sinusitis and ethmoiditis. A radical operation on the frontal sinus revealed pus and a hyperplastic mucous membrane undergoing polypoid generation. This was removed, and an opening was made into the nose. On the second day the eruption began to disappear, and on the twelfth day little was seen of the vesicles. Schiffer stated the belief that the disease was due to a peripheral reflex irritation from chronic frontal sinusitis. Fésüs reported a similar case in 1936. Fourestier, in 1939, described a case of zoster in a man following an operation on the lung for tuberculosis. During the operation the anesthetist injured the right malar region with the mask. Nine days later, a typical eruption of zoster developed, involving the right upper lid and the right side of the nose, and soon became bilateral. Snell, in 1896, reported a case of zoster that followed an operation for removal of cataract. Ammann mentioned 9 cases in which injury was followed by typical herpes zoster. He stated the belief that the virus of herpes simplex was identical with that of herpes zoster and that each disease could be caused by injury. Lloyd stated that any or all of the dendritic group might follow an injury to the eye, allowing the virus to enter the deeper tissues and then to travel along the nerve sheaths to the ganglion. Nicolau and Dragenescu, in 1936, reported a case in which the disease developed five days after an injury to the left

frontal and temporal regions. Involvement of the cornea was complicated with complete ophthalmoplegia. They stated the belief that a neurotropic virus passed from the skin over the sensory nerves to the motor nerves. Raecke, in 1910, mentioned a case of herpes zoster in a man aged 64 who was injured in the left eye; the injury was followed in ten days by violent ophthalmic zoster. He stated the belief that the mechanical irritation called the inflammation of the nerve into being. Terlinck, in 1928, reported a case of zoster in a woman aged 25 who had had an injection of alcohol into the gasserian ganglion for treatment of neuralgia. Total anesthesia of the first and second branches of the fifth nerve developed. One month later a typical ophthalmic zoster appeared, involving these two branches of the fifth nerve. Raecke stated the belief that the permeability of the ganglion cells was modified by the injection of alcohol, and thus the unknown herpetic virus penetrated the ganglion cells, ascended along the lymph tracts to the sensory neurons and produced the eruption. Grandi, in 1937, described a case of zoster in a man who was struck in the right eye while emptying a bag of fertilizer. Two days later he exhibited photophobia and conjunctival hyperemia. On the fifth day the cutaneous picture of herpes zoster appeared over the affected region, with edema of the lids and severe pain. One week later there was deep infiltration of the cornea, with posterior corneal deposits and iritis. The relation of trauma is explained on the assumption that there was loss of corneal tissue, whereby the herpetic virus was enabled to localize itself in the corneal parenchyma. Barraux, Assale and Bastouil, in 1935, described a case in a man aged 25 who was struck in the right orbital region with a football. Eight days later he experienced severe pains in the right orbit, with nausea and vomiting. Symptoms of meningeal depression developed, and he was hospitalized. There was severe cephalalgia in the right fronto-orbital region. Ptosis of the right upper lid was noted, with keratoconjunctival injection. Soon there developed a typical ophthalmic zoster, with mydriasis and keratitis. While the virus of herpes zoster is localized in the ganglions of the posterior roots and its lesions spread to the cord and the nuclei of origin of the sensory nerves of the cerebral area, corresponding to the posterior horn cells of the cord, the authors believe that trauma involving the vicinity of the usual site of election of zosteric manifestations may, by reactivation of the virus existent in the latter state in the organism, provoke the occurrence of zoster.

SYPHILIS

Numerous cases of herpes zoster have been reported in association with syphilis of the central nervous system. Syphilis has been given as a cause in cases reported by Schaller, Proust, Head and Campbell, Allbutt and Rolleston, Filatov, Busfield, Doggart, Picault, Clark, Rollet and Colrat, Ebaugh and Jefferson, Townes, Boner, Osterroht, Rosenmayer, Weill and Reys, Lagenhan, and Murzin. Dujardin found 9 cases of herpes zoster in 1,200 cases of syphilis. Morax commented on the frequency of syphilis in patients with zoster. Brown and Dujardin, in 1919, stated that the frequency of occurrence of herpes zoster is four times as great in syphilitic as in nonsyphilitic persons. Schaller concluded that symptomatic herpes zoster occurred with comparative frequency in cases of syphilis of the central nervous system. Head and Campbell, of 21 cases of zoster, found positive evidence of syphilis in 14. However, the zoster may be due to the arsenical treatment. The slight meningeal irritation in syphilis may open the road to infection with the virus of herpes zoster, and arsenical treatment, or inefficient arsenical treatment, may predispose to herpes zoster. Vailiere-Vialeix, in 1931, reported a case of a female with parenchymatous keratitis following ophthalmic zoster. The patient had a positive Wassermann reaction, and after antisyphilitic treatment the vesicles rapidly disappeared. Lépine, Christy and Feuillade, in 1932, cited a case of a man of 32 with corneal ulceration and violent neuralgia. In this case the herpes zoster occurred two months after right hemiplegia. They stated the belief that in this case there was a pathogenic correlation. The signs of hemiplegia and zoster retrogressed rapidly. They thought that the zoster was due to an infectious lesion, localized in the protuberance involving the root of the right trigeminus nerve. Renard described a case in a woman of 31 years. The corneal miscroscope revealed deposits on the posterior surface of the cornea and exudate in the pupillary area. The Wassermann reaction was positive. Treatment was instituted, and all symptoms of zoster disappeared. Three months later the left pupil was dilated and immobile. There was no reaction to light, in convergence or consensually. There was slight contraction in accommodation. The paralysis in this case developed long after disappearance of all symptoms of herpes zoster. Renard believed that a primary attack of meningeal syphilis doubtless involved the gasserian ganglion and produced the zoster and the paralysis of the iris. It is difficult to decide whether

the pupillary paralysis is due to herpes zoster or to infection with Treponema in cases in which syphilis exists.

ENCEPHALITIS

Herpes zoster has been found associated with evidence of involvement of brain tissue. Symptomatic zoster may follow a lesion of the nervous system, and in some cases it is questionable whether the zoster is secondary to encephalitis of different origin or whether the encephalitis is due to the zoster. Most investigators believe that encephalitis may damage the first sensory neuron and lead to an outbreak of zoster or that the virus may cause the encephalitis by extension. Netter reported that in 1 per cent of cases encephalitis was accompanied with supra-orbital herpes zoster followed by paresthesia of the skin. Schiff and Brain reached the conclusion that there was a group of cases in which an extension of zoster infection had produced the clinical picture of encephalitis. Bedson and Bland supported this view. Tilney and Howe, in 1920, described a case of encephalitis, characterized by weakness, blurred vision and diplopia. After three weeks a typical herpes zoster developed along the course of the third nerve. Similar cases have been reported by Wilson, Netter and Annard.

ARSENIC POISONING

Numerous cases of ophthalmic zoster following arsenical treatment have been reported. Arsenic may predispose to the disease in some persons, but it is possible that the drug may cause irritation of the gasserian ganglion, and this has been observed at autopsy. Hutchinson reported the first case of ophthalmic zoster due to arsenical poisoning in 1869. Other cases have been reported by Head and Campbell, Powell, Cohn, Gerson, Pearce, Wilbrand and Saenger, Pergola, Weber and Broadbent. Pearce, in 1930, described a case in a girl of 7 years, with chorea, who was taking an arsenical preparation in treatment. When all the symptoms of chorea had disappeared, there developed typical ophthalmic zoster, probably the result of arsenical poisoning of the ganglion. Arnstein, in 1922, mentioned 6 cases of zoster following arsphenamine treatment in 2,211 cases of disease of the skin. He considered the eruption in these cases to be some form of the Herxheimer reaction. It is almost impossible to determine whether the zoster is due to the treatment or to the disease from which the patient is suffering. Palazzi, in 1921, described a case in a man of 42 who was under treatment for acute pulpitis of the second lower right molar tooth. The carious cavity was cleansed, and arsenical treatment was applied for cauterization of the pulp. A few hours later the patient complained of severe pain over the entire right half of the head, particularly in the fronto-orbital region. Shortly after typical ophthalmic zoster developed. Arsenical medication applied to the pulp may produce an irritation capable of manifesting itself reflexly in the form of zoster and may be an evident expression of arsenical idiosyncrasy. Until a few years ago, the possible occurrence of odontogenic zoster was not considered, but numerous instances of the appearance of zosteric eruptions in consequence of dental irritation have been recorded in which there had been no arsenical medication. Potassium iodide and bismuth preparations have been reported as exciting or supplemental causes of zoster by Griffith, Netter and Urbain, Jacquet and others. Many cases of herpes zoster have been described as following carbon dioxide poisoning. Severe inflammatory changes have been observed in the ganglion in cases reported by Cohn, Kozlowski, Sattler and Kaposi.

ACUTE DISEASES

Sicard, in 1905, reported a case of a boy of 12 years with bilateral parotiditis, due to mumps. A few days later zoster developed, localized over the left half of the face, in the frontal, supra-orbital and superior palpebral regions, with symptoms of meningitis. These symptoms rapidly disappeared, and recovery followed. In this case the first and second branches of the trigeminus were affected. The zoster was attributed to the cutaneous trophic disturbance produced by extension of the meningeal process to the gasserian ganglion. Accordingly, in this case the trigeminal zoster in the course of mumps provided evidence apparently of a meningeal process at the base of the cranium. Galezowski mentioned a case of zoster which occurred during the course of pneumonia. Bane, in 1916, described a case of zoster in a man following an attack of grip, and Schäffer published a case in which the condition followed bronchopneumonia. Many cases have been reported in which the disease was a complication of leukemia, as cited by Freund, Glaubersohn and Márquez. Diabetes has been ascribed as a cause of zoster by Atkinson. Schiffer, cited by Jessop, mentioned a case in which a sarcoma of the sphenoid bone was found, and Charcot mentioned a case of zoster occurring in the course of an orbital

tumor. Lucic, in 1930, described a case of the disease in a man, with corneal vesicles. Eight months later, after a submucous resection, the corneal symptoms reappeared, and hospitalization was necessary, with eventual loss of the eye. Chance stated the belief that sinus disease has a close relation to ophthalmic zoster as a contributing cause, and that filaments of nerves supplying the sinuses are affected in their passage through the sinuses and thus transmit infections to the nerve branch. Carter told of a case of zoster following lumbar puncture. It was thought to be due to traumatic irritation transmitted to the dorsal root ganglion. Coppez described a case, in which one year after the attack, the eye became inflamed and painful at each menstrual period.

CHICKENPOX

Much clinical evidence has been presented to associate herpes zoster and chickenpox. Many writers have drawn attention to this close relationship, among them von Bókay, McEwen, Jacobi, Bedson and Bland. Work on herpes zoster and varicella is extensive, and it has been demonstrated on clinical and experimental grounds that there is a definite etiologic relationship.

Netter and Urbain claimed on the basis of deviation of complement that the virus of herpes zoster is identical with that of varicella. Amies found elementary bodies in the serum of patients with zoster and varicella which were morphologically similar. Many investigators, among them Brain, Paschen and Pickard, have claimed that the antibodies are identical. The histologic characteristics of the vesicle are the same in chickenpox as in herpes zoster, and it has been possible to observe evidences of cross contamination, while the fixation reaction is the same with both antigens. However, varicella is inoculable, and herpes zoster is not; the hematologic formulas are not the same; neither is the spinal fluid changed in varicella, while it is altered in zoster. Animal experimentation to prove the similarity of the viruses in the two diseases, however, has not been successful. The investigations of Netter and Urbain showed that there were antibodies in the blood of the patient suffering from herpes zoster. Deviation of the complement occurred when the crusts from the vesicles of zoster or varicella were used as antigen against the blood serum of patients with zoster, and the same results were found with the antigens and the serum of patients with chickenpox. In 1926, these authors reported 100 cases of herpes zoster, in 93 of which deviation of complement occurred. De Lange, in 1923, claimed to have demonstrated antibodies in the blood of a patient with zoster. Bedson and Bland substantiated these claims. The relationship of the two diseases is strengthened by the interchangeable fixation reactions and the transmission of zoster by patients with varicella and the production of chickenpox by inoculation with the zoster virus. Pickard claimed that the virus causing varicella and zoster has two phases, which are transmutable. The zoster phase has its seat in the posterior root ganglion, from which the infection may spread locally, involving the gasserian ganglion, and extend along the sensory nerves to fibrous tissue covered with epithelium, where it reverts to the varicella stage.

In view of the number of cases of herpes zoster following varicella and of cases of varicella following zoster, either disease may be the starting point for an epidemic of either type of disease. Von Bókay, in 1898, was the first to call attention to the relationship existing between epidemics of varicella and of herpes zoster and reported that most cases of herpes zoster occurred one month after epidemics of varicella had reached their height. Such a relation has been emphasized by Netter and Urbain, Brain, Paschen, Amies and Pickard. Lévine stated the belief that epidemic zoster and epidemic varicella were produced by modified strains of the same parent virus, which would explain the interchangeable fixation reactions in the two diseases and the high protection each disease gives against recurrence. He reported 6 cases of zoster following exposure to varicella and 3 cases of varicella following herpes zoster. Low considered that the two diseases have identical viruses and differ only in their mode of attack.

Some investigators believe that the virus which causes herpes zoster in the adult may cause varicella in the child. This belief is based on the development of zoster in adults caring for patients with varicella, and many instances have been cited in which there has been the curious incidence of varicella in children after an adult member of the family had herpes zoster. Le Feuvre, in 1917, stated that under certain conditions herpes zoster may be the starting point of an epidemic of varicella. He reported 41 cases of varicella following exposure to zoster. The interval between the zoster and the varicella and between the varicella and the zoster averaged fourteen days. Netter collected 174 cases of varicella following exposure to zoster. The incubation period varied from seven to twenty-

four days. Renard and Halbron, Sayers, Padovani, Busfield, Roxburgh, Ardouin, Low, Paton, Viallefont, von Bókay, Roberts and Quick have described such cases. Hill found 9 cases of varicella following zoster and 1 case of zoster following chickenpox. Netter and Ernoul, in 1934, reported an interesting case. During an operation for evisceration of the globe following purulent dissolution of the cornea in the course of ophthalmic zoster, a physician pricked himself in the hand. Twenty-six days later there was a typical eruption of zoster in the region of the extension of the left median nerve. Three weeks later his two children became ill with varicella. It was presumed that the virus, by following the nerves, had penetrated into the intervertebral ganglions and that it must have traversed the same route in an opposite direction in order to produce a typical herpes zoster in the corresponding cutaneous region.

It is less frequent for zoster to follow exposure to varicella, although Netter collected 25 cases of such an occurrence in 1928. Thus, zoster may be followed by zoster in one person and by varicella in others and the same is true of varicella, or a person may have both diseases at the same time. Almost all the patients with varicella from exposure to zoster have been children and the patients with zoster from exposure to varicella have been adults.

Herpes zoster and varicella have occurred at the same time in the same person. A two phase virus might produce this condition, each phase being transmuted into the other. Von Bókay recorded 29 cases in which zoster and varicella occurred simultaneously. Many similar cases have been recorded by Ormsby, Pollitzer, Schamberg, Stelwagon, Corlett, Genet, Barling and Cahill, Le Feuvre, Hunter, J. B. Harris, Schiff and Brain, Watt, Davenport, Zander-Olsson, Barraux and associates and Guillian and associates. Although the simultaneous occurrence of zoster and varicella has often been reported, the relation of the two disorders has thus far not been explained. The histologic appearance of the vesicles in the two diseases is similar. Perivascular infiltrates are found around the intervertebral ganglions in both diseases. However, there is yet no evidence to show conclusively that varicella and zoster possess the same cause and are due to an identical virus. Brooks, in 1931, reported the case of a man aged 70 who was admitted to the hospital complaining of persistent hiccup. There was a history of malaise for two weeks previously; then hiccup began and had been persistent for three weeks. Shortly after being hospitalized, he broke out with typical varicella and a profuse zoster rash. This chain of events seems related to a virus infection and illustrates the close relationship of zoster, varicella and encephalitis and between encephalitis and hiccups. Cornil and Blanc, Rokitskaya, and Shelmire and Shelmire have reported similar cases.

Low suggested that varicella is an infection of the blood while in zoster the virus reaches the posterior root from the spinal fluid, to which it gains access through the nose. He stated that they differ in their manner of attack, zoster spreading by way of the lymphatics and varicella by way of the blood.

Paton held a similar view and expressed the belief that the two diseases might be due to the same virus, differing only in intensity. Stern asserted that the virus which causes zoster might revert to the varicella phase, after extending along the sensory nerves from the ganglion, when it reached the cells of ectodermal origin. Barker, in 1939, reported 3 cases of herpes zoster ophthalmicus in males, in which there was a generalized vesicular eruption on the trunk and extremities, clinically similar to varicella. The latter, he believed, however, to be an extension of the zoster itself or to be due to a dissemination of the virus. The generalized eruption disappeared in ten days, and the original zosteric lesions followed the usual course. Kundratitz claimed to have produced varicella by inoculation with zoster vesicles. In 1925 he was able to prove that the virus of varicella and the virus of herpes zoster are closely related, by immunizing children against varicella by means of the inoculation of material from patients with zoster. In 1927 he reported 26 successful attempts. This inoculation was also successfully made by Netter and others. A successful inoculation protected against subsequent infection with zoster and also against varicella. Lipschütz, in 1921, was able to inoculate rabbits with herpes zoster by rubbing vesicular fluid into their scarified corneas, with resulting opacities. Histologic study showed hypertrophied and swollen connective tissue cells; in the nuclei of the epithelial cells and in the tissue cells were found intranuclear inclusion bodies. Cole and Kuttner, in 1925, in a series of cases, were unable to confirm the observations of Lipschütz regarding the experimental production of specific lesions in the corneas of rabbits. It is very questionable whether herpes zoster can be so transmitted. Many other investigators, namely, Kraupa, Baum, Löwenstein, Netter and Urbain, and Doerr, reported entirely

negative results from the inoculation of the vesicles of herpes zoster into rabbit corneas. Some investigators have claimed that the etiologic agents of varicella and of zoster are the same, while Cole and Kuttner stated the belief that zoster is due to a modified virus of herpes simplex. Tyzzer, and Teague, Goodpasture and Lipschütz claimed to have found intranuclear inclusion bodies in the epithelial cells of the cutaneous lesions of all three diseases.

HERPES SIMPLEX

Herpes zoster is thought by some investigators to be related to other disorders caused by a neurodermotropic virus, such as herpes simplex, although the latter does not produce immunization, is inoculable, exhibits no neural distribution and fails to show the fixation reaction of herpes zoster. The clinical manifestations of the two diseases are different, and the histologic lesions are not the same. Neuralgia does not precede the eruption. Herpes simplex lasts only a few days and is a local lesion; sensibility is not diminished, and the skin does not scar. The neuralgia pain is less severe and less persistent. Ocular tension is not reduced.

In recent years a vast amount of work has been done on the various manifestations of herpes of the cornea and herpes zoster. Buhnemann, in 1937, stated that two diverse views are entertained concerning the identity of the viruses of herpes zoster and herpes simplex. One of these opinions is to the effect that the herpes neuralgias of zoster represent the form of herpes with an especially prominent neural component. The proponents of this theory affirm an etiologic relationship of the two pathologic agents, which, though they may differ morphologically, nevertheless produced the same specific injuries to the nerves. Adherents to the other opinion, while they admit the alleged identity of the viruses so far as it relates to the production of vesicular eruptions on the skin and of injuries to nerves, insist that these pathologic agents are essentially quite distinct. The latter hypothesis is now accepted by the majority of authors, who conclude that zoster is produced by a specific pathologic agent and that the virus is not identical with the virus of herpes simplex, although the pathologic pictures of the two conditions agree in some details.

At times there is confusion in diagnosis between herpes zoster and herpes simplex, especially when the vesicles of herpes simplex appear over the distribution of a nerve or when they recur. In some cases the cornea reveals approximately the same clinical picture with both herpes zoster and herpes simplex, such as minor epithelial defects, superficial opacities, parenchymatous opacities, ulceration, and at times panophthalmitis, resulting from secondary infection.

Some authors have suggested that herpes zoster, herpes simplex, encephalitis and varicella are probably caused by the same virus. Many believe that a close relationship exists among the viruses producing anterior poliomyelitis, chronic epidemic encephalitis and herpes zoster because the pathologic changes that take place in the central nervous system are similar in the three diseases: the round cell infiltration of the gasserian ganglion in zoster, of the anterior horn cells in poliomyelitis and of the substantia nigra in encephalitis. The relationship of the herpetic virus to the virus of epidemic encephalitis is apparently so close that the majority of investigators unhesitatingly designate both etiologic agents by the general denomination of herpetoencephalitic virus. Lloyd stated that the encephalitis following grip and the herpetic lesions following grip form the basis of the belief that the herpetic virus is the etiologic agent of encephalitis, multiple sclerosis, poliomyelitis and ascending paralysis. The histologic changes in the central nervous system in herpes simplex are similar to those in encephalitis, although inclusion bodies have not been found in the latter. Levaditi expressed the belief that the two diseases might be manifestations of infection with the same virus. Duke-Elder stated that herpes simplex was closely related to encephalitis but only doubtfully so to herpes zoster. Flexner produced anterior poliomyelitis in monkeys by infecting them with cultures obtained from vesicles of herpes zoster.

Many investigators believe that zoster is not caused by any specific organism and has a common etiologic agent with herpes simplex. The evidence that zoster may result from infection with the virus of herpes simplex rests on a small number of cases and needs further investigation. Luger and Landa claimed to have obtained the virus of herpes simplex from vesicles of zoster. Teague and Goodpasture stated that they had produced zoster-like lesions in the skin of rabbits by inoculation of the virus of herpes simplex. Grüter inoculated the cornea of rabbits with material from patients with zoster, and mild keratitis resulted. These investigators concluded that the reaction was specific and attributed it to the virus of herpes simplex of low virulence. They concluded that the two viruses were closely related, probably differing only in virulence. They stated that herpes simplex was a dermotropic strain of the neurotropic zoster virus and that the two diseases were

different manifestations of the same entity. The consensus, however, is contrary to this conclusion. Androgé stated that the virus of herpes simplex was predominantly dermotropic, that is, the cutaneous lesions were more numerous than the neural lesions but that the contrary was true of zoster virus, which was predominantly neurotropic.

On the other hand, Löwenstein, in 1920, proved experimentally the difference between herpes simplex and herpes zoster. Zoster could not be transmitted to the cornea of rabbits, but all such attempts with herpes simplex were successful. Mariana was able to transfer various types of herpes simplex from one rabbit cornea to another, with changes in the nervous system, but in the case of herpes zoster he did not find changes either in the eye or in the nervous system. Lloyd claimed that the vesicles of zoster do not contain virus which can be transmitted to the corneas of rabbits but that the vesicles of herpes simplex do contain a transmissible virus.

The serum of patients convalescing from zoster gives complement fixation with the antigen preparations from zoster vesicles, while the serum of patients with herpes simplex shows no such properties. Although herpes zoster is always included among the diseases due to nonfiltrable viruses, direct evidence in support of this view has not been produced. The work of Netter and Urbain, Bedson and Bland, Aitken and Brain, Kundratitz and Brussgaard indicates that the serum of patients with zoster contains a specific antibody the presence of which can be detected by complement fixation tests, using as antigen diluted fluid from the zoster vesicles or a suspension of the cutaneous crusts. According to the findings of these investigators, zoster may be regarded as an infection with a virus, which leaves evidence of itself, after the illness has passed, in the form of antibodies in the serum. Weizel reported a case of a patient who had received a transfusion of blood from a patient with herpes simplex and in three days had a typical eruption of herpes zoster on the cheek. Animal inoculation of material from these vesicles was unsuccessful. Injection of fluid from vesicles into the author's arm produced a papular eruption, which was not like any known exanthem.

PATHOLOGIC FEATURES

Von Bärensprung, in 1861, attributed the disease to lesions of the posterior root ganglion and was the first to report on pathologic investigations. In 1865 Charcot and Catard noted injection of the capillaries and nerves in the ganglion. In 1870 Wagner and Weidner each noted changes in the ganglion and nerves, and one year later Wyss observed small hemorrhages and round cell infiltration in the ganglion. In 1874 Jaclard published an account describing hyperemia in the ganglions, intense cellular infiltration of connective tissue, destruction of connective tissue bands and alteration of ganglion cells. Sattler, in 1875, also found infiltration of the ganglion with small round cells, with destruction of ganglion cells and changes in the ophthalmic division of the nerve. Kaposi, in 1876, found hemorrhages in the ganglion, surrounded by areas of exudation and infiltration. Ganglion cells were destroyed, and parts of the ganglion were sclerosed. Chandelux, in 1879, observed similar alterations in the ganglion, as did Leudet, in 1887, and Lesser, in 1881. In 1883 Pitres and Vaillard noted changes in the peripheral nerves, which were confirmed, in 1884, by Curschmann and Eisenlohr. Dubler, in 1884, concluded that the condition was a perineuritis and that the changes in the ganglion were secondary.

Head and Campbell, in 1900, reported detailed observations on the posterior root ganglion, in the posterior root itself, in the peripheral nerves and in the spinal cord in 23 cases and definitely established the pathologic picture. If the patient died at the time of the eruption, the ganglion was in a state of severe inflammation. The interstitial tissue was crowded with small round cells, especially at the periphery and in the tissues of the central part of the ganglion, around areas of extravasated blood. The substance of the ganglion might be destroyed to a greater or less extent; but if hemorrhage had occurred at all, it was always present in the dorsal half of the ganglion. In the center of the hemorrhagic focus the ganglion cells were destroyed. In the surrounding zone of small round cells, the remains of ganglion cells were usually evident. The nuclei of the ganglion cells were swollen; the substance of the bodies of these cells were devoid of definite structure, and the chromophilic Nissl particles were not seen. These changes varied in extent in different cases. The sheaths of the inflamed ganglion were invaded with small round cells. The vessels were engorged, and extravasated blood was often seen.

In some cases the inflammation subsided and left no change in the posterior root ganglion. But the greater the severity of the eruption, the more certain were permanent changes to be found in the ganglion. As the inflammation subsided, absorption began. The effused blood underwent retrogressive changes and might remain as a mass of brown granular

material. Ultimately the focus of the inflammation became converted into fibrous tissue, and the extent of this change depended on the severity of the inflammation. If mild, there was little change; if severe, scar tissue formed. In this scar tissue the ganglion cells and nerve fibers were destroyed. The sheath over the scar tissue was thickened and altered in appearance.

Secondary degeneration, similar to changes in the ganglion, occurred in the posterior nerve roots. Head and Campbell showed that the posterior root ganglion was the center of the inflammation, which spread up and down the nerve to some extent. Sometimes the degeneration extended into the posterior column of the cord and down the sensory nerve and its branches to the skin.

Zoster of the branches of the fifth nerve was associated with a similar lesion in the gasserian ganglion, which corresponds to a posterior root ganglion. This lesion caused secondary degeneration in the sensory root of the gasserian ganglion.

The peripheral nerves also showed changes, which could be traced back to the fine twigs that passed into the skin. In time the products of degeneration were removed from the nerve; if the ganglionic lesion was not severe, no abnormality was seen, but if the inflammation was severe, the fibers were replaced with fibrous tissue.

Head and Campbell observed that the changes in the posterior root ganglion resembled closely the changes found in the anterior horn with anterior poliomyelitis. In all their cases the anterior root was normal. Hunt confirmed this observation.

Head and Campbell suggested that the production of the rash was due to an intense irritation in the cells of the ganglion, which normally subserve the function of pain. If the rash were due to increased activity in the posterior root ganglion, causing an increase in the normal trophic impulse, it would be expected to produce a more uniform effect on the skin than it actually did, for the lesions in the ganglion were usually diffuse, and not confined to limited areas.

Head and Campbell concluded that zoster of the branches of the fifth nerve was associated with a lesion in the gasserian ganglion and that the lesion caused secondary degeneration in the sensory root of the gasserian ganglion. They stated the belief that the virus responsible is neurotropic and has a special affinity for spinal ganglions, where changes occur, varying from acute lesions to chronic scar formation.

In cases of symptomatic, or secondary, herpes zoster, Head and Campbell found that the blood supply to the ganglions was definitely disturbed and stated the belief that the process was one of acute destruction of ganglion cells due to vascular changes, rather than of damage by poisoning, with consequent degeneration and death of the cells. The changes in the posterior root ganglion consisted in acute interstitial inflammation, accompanied with necrosis of the ganglion cells. The agent responsible showed a specific attraction for one or more posterior root ganglions, especially those which contained a preponderance of small ganglion cells. They stated the belief that these small cells, among other functions, subserve the pain sense and that their involvement results in the severe neuralgia of zoster. Before the eruption appeared, it was possible to map out the area later occupied by the eruption by means of the hyperalgesia present. They stated the opinion that the eruption was not produced by special trophic nerves but that it was due to the intense irritation of the cells in the ganglion.

Lauber, in 1905, observed necrosis of nerve fibers and evidence of neuritis and perineuritis of the involved branches of the fifth nerve, and in the corresponding portions of the ganglion there were inflammatory and necrotic foci. The neuritic symptoms decreased in proportion to the distance from the ganglion. André-Thomas and Heuyer, in 1912, confirmed the findings of Head and Campbell in a patient who died three days after an eruption of herpes zoster. Similar observations were made by Sunde, in 1913.

Wohlwill reported a fatal case, in which autopsy revealed infiltration of the gasserian ganglion with lymphocytes and plasma cells. The infiltration was confined to a part corresponding to the first branch of the fifth nerve. Infiltration of some intensity was noted in the root of the trigeminal nerve and in the proximal portion of the first branch. The adventitia and media of a small artery in the root showed conspicuous infiltration in the lymphocytes and plasma cells. Fischl found similar conditions in the ganglions and periganglionic tissues, as did Rollet and Colrat, in 1926, and Hesser, in 1924. Kreibig, in 1938, described a case of a man of 68 who died nine days after an outbreak of bilateral ophthalmic zoster. Practically in their entirety the ganglion cells exhibited granular disintegration of protoplasm and contraction of the nucleus. The pronounced alteration in the peripheral nerves, with extensive demarcating infiltrates, was in contrast to the slight altera-

tions in the gasserian ganglion and indicated clearly that in this instance the initial phenomenon appeared in the skin and the uvea and that the pathologic process then extended centralward.

In years past, conflicting theories have been advanced regarding the pathologic process of herpes zoster. Levaditi stated the belief that there was a *tonus immunotrophique* in each spinal segment which prevented infection and that if this was lowered, the organism established itself in the segment of that part of the body supplied by it. Vogt asserted that herpetic diseases were endogenous and that trauma in an area of lowered resistance rendered the area susceptible to viruses already present in the body. Sieur, Poulard and others divided the disease into three forms: a neuritic form, which affects the peripheral branches of the ophthalmic division; a rhizomeric form, which implicates the ganglion, and a metameric form, in which the lesions lie in the pontomedullary nucleus of the fifth nerve.

The point of origin of the disease is not known, whether central, epidermal or neuronal. Most investigators, including Lauber, Wyss, Weidner, Kaposi, and Head and Campbell, have stated the belief that the primary focus was in the ganglion and that the neuritis and degeneration of nerve fibers were secondary developments. They explained the lesions of the skin and cornea solely on a neuritic basis. Some workers believe that a lowered trophic influence permits the entrance of the herpes virus, allowing it to reach the deeper parts in the eye, but this etiologic factor is disputed by most investigators. Pickard did not agree with this assumption because the cutaneous vesicles did not have a uniform effect on the skin. Meller concluded that the epithelial changes were due to trophic disturbances produced by inflammation in the more proximal portion of the nerve. He stated the opinion that inflammatory foci in the ganglion might produce necroses and inflammatory phenomena within the eye without direct extension of the inflammation throughout the course of the nerve. He found characteristic perineuritic infiltration of the ciliary nerves, which could be followed from behind into the interior of the eye, wherever the diseased nerves branched. Gilbert showed sections in a case in which there was perineuritis of the ciliary nerves near the ganglion. Choroiditis was also present, a condition which he felt was primary and the neuritis secondary. He claimed that zoster was a local manifestation of a general disease and that the ocular lesions were probably a perineuritis of the ciliary nerves, a hypothesis which would account for the deep keratitis and cyclitis. Friedreich held a similar opinion. Gardilčić, in 1937, found two areas of necrosis in the sclera which he stated were due to trophic disturbances from diseased nerves. Duke-Elder expressed the belief that ophthalmic zoster was dependent on a trophic disturbance, associated with a radiculoganglionic and sympathetic infection with an unknown virus, and that the essential cause of the neurotropic disturbance was unknown. Van der Scheer, and Aubaret and Margaillan held a similar opinion. According to Sicard, Sicard and Robineau and Vörner, the primary role which the sympathetic nervous system plays in neuralgias due to peripheral neuritis and in vasomotor disturbances which precede the eruption argues in favor of intervention on the radicular sympathetic hilus and serves in part to confirm the theory of ganglioradiculosympathetic zoster. With the trigeminal nerves is associated the gasserian ganglion, of the posterior radicular system of the cord. The other, so-called ophthalmic, sphenopalatine and otic, ganglions belong to the sympathetic group and are themselves dependent on the great superior sympathetic cervical ganglion. Accordingly, in ophthalmic zoster there is disharmony between the elements of the sympathetic system and the sensory nerve fibers.

If a neuritic process is present, paralysis of the sphincter of the iris is readily explained. While the ophthalmic nerve contains no motor fibers which supply the intrinsic muscles of the eye, it is known that sensory fibers from the trigeminal nerve reach the ciliary ganglion by way of the ophthalmic nerve. The ciliary ganglion is the actual iridoconstrictor center, which governs movements of contraction of the pupil. A lesion of the ganglion will abolish this contraction, and the tension usually becomes lowered and the pupil dilates under the influence of the dilatory system. Fibers of the trigeminus proceeding from the ophthalmic nerve and extending to the ciliary ganglion are affected by inflammatory lesions, which, in turn, destroy the motor elements of the ganglion.

On the other hand, Dubler, and Curschmann and Eisenlohr maintained that the chief emphasis must be placed on the peripheral neuritis. They asserted that the pathologic process in the ganglion is a probable result of the peripheral changes or may be coordinate with them. Wilbrand and Saenger accepted this view but were not quite so positive about the neuritis. Orr and Rows, and Montgomery and Culver also stated that the disturbance was an ascending process.

Teague and Goodpasture stated the opinion that the virus incubated at the site of the inoculation passed along the afferent nerve to the ciliary ganglion, producing hemorrhagic inflammation, and then proceeded along branches of that ganglion to the skin, where the vesicles developed. Marianesco and Draganesco stated that the infection was located in the sensitive nerve endings and secondarily involved the motor nerves, with dissemination by the veins and lymphatics. They traced the infection along ciliary neryes to the meninges. Sédan was of the opinion that the virus was transmitted to the ciliary ganglion over sensory nerve fibers from the nasociliary nerve of the fifth nerve.

Wohlwill expressed the belief that the disease was due to an ascending infection, utilizing the lymphatics of the nerves. He stated that disease of the primary sensory neuron was necessary for the development of zoster but that it alone was not capable of producing the cutaneous picture; in his opinion, it prepared the soil for the virus, which produced the vesicles. This preparation of the soil apparently occurred through reflex disturbance of vasomotor innervation. Wohlwill assumed a reflex causation of the cutaneous lesions by vasomotor disturbance and stated that this phase might come to an end as soon as the reflex arc was interrupted, by the complete degeneration of some of the sensory components. Montgomery claimed that the zoster virus had a special affinity for nerve tissue.

Some investigators believe the disease to be due to irritation of vasodilator fibers, and not to an extension of inflammation to the terminal filaments of nerves in the skin, and they are of the opinion that the eruption is caused by inflammation of the sympathetic fibers distributed through the arteries, which produces distention and possible rupture of the capillaries. The sympathetic fibers arise from the superior cervical ganglion and pass along the nerve to the terminal branches of the ophthalmic artery. As the inflammatory process affects the ganglion and nerve, the accompanying sympathetic, vasodilator, fibers are affected, leading to vasodilation. They hold that the pathologic process is induced by excess fulness of certain vascular regions and is characterized by areas of vesicles and subepithelial infiltration. The exponents of this vasomotor theory are von Recklinghausen, Ebstein and Abadie, von Tschermak, Wohlwill, Aubineau, Nobl and others.

In 1898, Abadie expressed the opinion that herpes zoster ophthalmicus was provoked by a pathologic state of the arteries and that lesions of the ophthalmic artery and its branches were the cause of the zoster phenomena. He stated the belief that the eruption was due to vasomotor disturbances and attributed the limitation of the eruption in the area of distribution of the ophthalmic nerve to disturbance of the sympathetic fibers accompanying the arteries in this region. He pointed out that the vessels in the area innervated by the maxillary branches of the fifth nerve receive their vasomotor nerves from a different sympathetic source. But this would not explain the corneal lesions or the corneal anesthesia. He stated that the ganglion was altered by obliteration of its nutrient vessels. He expressed the belief that the ocular paralyses were also secondary to vascular lesions and were not due to extension of the infection from sensory nerves to motor nerves in the orbit or the cranium. Aubineau agreed with this theory and reported autopsy observations in detail. He noted that the arteries of the brain were atheromatous and dilated, with numerous leukocytes in their lumens and with periarteritis, revealed by an abundance of cellular elements and by hemorrhages at the periphery of the vessels. A thrombus was noted in the extremity of the ophthalmic artery, with thickening of the intima, and similar changes were observed in the smaller ramifications. The gasserian and ophthalmic ganglions showed vascular lesions of endarteritis and periarteritis. The nerve sheaths were thickened and infiltrated with cells in the process of multiplication. There were zones in the ganglions in which round cells presented clearly the aspect of lymphocytes. The arterioles near the ganglions exhibited proliferated endothelium, and some sections revealed minute hemorrhagic foci between the cells. An irritative or infectious process extended to the vessels and nerves of the muscles and to connective tissue which separated muscle fasciae. In the muscles were noted masses of lymphocytes, indicative of inflammatory foci, while muscle fasciae, instead of lying side by side, were frequently separated by new-formed connective tissue. The arteries and arterioles were all altered, and nerve bundles exhibited thickening and cellular multiplication of their sheaths. These examinations demonstrated a constant predominance of arterial lesions. Nobl, in 1911, argued that herpes zoster is a vasomotor disturbance; he stated that if zoster is regarded as a vasomotor phenomenon, it is possible that at one time various nerve centers of unequal sensitiveness are stimulated and injured, in varying degrees. His explanation is that the initial inflammatory, angioneurotic injury to the vessel wall is to be considered as an expression of a sympathetic reflex neurosis, which leads first

to edema from vascular dilatation, and later to the epithelial neurosis. The irritation of the sympathetic vasodilator center is distributed through the avenues of sensation, whereby the disease of the spinal ganglions occasions the afferent irritation of the reflexes. Then the excitant acts with increasing intensity on the spinal cord and extends to the sympathetic ganglions. It is by irritation of the latter that the vasomotor phenomenon occurs. The return of the phenomenon to the source of the irritation explains the intense local appearance of the eruption in the skin of the corresponding nerve.

Kreibich observed that in the terminal stages of dementia paralytica there is often associated a typical herpes zoster, which he stated to be due to vasomotor changes in the skin associated with organic nervous disease. He concluded that vasomotor changes are a reflex phenomenon, set off by irritation of any part of the afferent limb of the reflex arc. He stated the belief that centrally arising stimuli were capable of setting off vasomotor reflexes. Arnstein agreed with Kreibich that the cutaneous lesions occur through irritation of the Kreibich reflex arc at any point of its afferent, efferent or central connection. Zeeman stated that the anoxemia of the involved tissue, produced by vasomotor spasm, is responsible for the epithelial changes, in conjunction with toxins liberated by the etiologic agent within the nerve. Bézi expressed the belief that occlusion of a vessel produced hemorrhagic necrosis, with a leukocytic zone, and that purulent inflammation followed. He concluded that the central process antedated the peripheral pain and the cutaneous eruption.

Kundratitz, however, claimed to be able to demonstrate that the virus is in the vesicle; if this is so, the cutaneous lesions are not trophic or vasoparalytic, as many believe.

It has proved impossible for most investigators to reproduce the disease experimentally, or at least to obtain transmission in series. Accordingly, the nature of the zoster virus is unknown, but the disease is assumed to be a specific infectious process, due to a nonfiltrable neurotropic virus.

However, Rosenow and Oftedal made a complete report on their experimental work, in which they endeavored to prove that herpes zoster was a streptococic infection, gaining entrance to the circulation through diseased tonsils or pockets of pyorrhea and possessing an elective affinity for the posterior root ganglions. In animals, they produced typical herpetic lesions centrally and peripherally by intraperitoneal and subcutaneous injections. The ganglions corresponding to the herpetic area in the skin showed hemorrhage and edema. Grüter claimed to have produced an eruption of herpes zoster by injection of a suspension of brain substance from animals which were infected with herpes zoster. Flexner, and Teague, Goodpasture and Lipschütz reported that they produced the disease in animals by inoculation of the virus. Goodpasture claimed to have demonstrated the presence of the virus in the intervertebral ganglions, as well as in the vesicles. Kuchner, in 1933, stated that he had produced the disease in the corneas of rabbits by applying scrapings of epithelium from the corneas of 36 patients with herpes zoster. Von Szily reported having produced uveitis in the eyes of rabbits with virus from patients with herpes zoster, which uveitis was transmitted to the opposite eye, giving a clinical and histologic picture resembling that of sympathetic ophthalmia. This claim was confirmed later by experiments by Gifford and Lucic, in 1927, showing that the extension occurred via the optic nerve and the optic chiasm to the other eye.

Sunde, in 1913, reported observations at autopsy, made three days after the infection. The gasserian ganglion was twice the size of that on the other side. Sections showed hemorrhagic points, and microscopic examination revealed acute inflammation, hyperemia, round cell infiltration, capillary hemorrhage and fibropurulent exudate. In all sections gram-positive cocci were found, some in short chains. Bézi reported similar findings seventeen days after the initial infection. In the medial two thirds of the ganglion was observed a fibrinopurulent exudate with pronounced hemorrhage. In the sheath of the third nerve a similar purulent exudate was noted. Many large cells containing fat granules surrounded the degenerated myelin sheaths. Bézi demonstrated many bacteria in the areas of degenerated myelin sheaths, predominantly lancet-shaped, gram-positive diplococci. On the other hand, Magnus, in 1902, 1903 and 1906, found no organisms in the ganglions of the posterior horns, and Scheel, in 1904, and Arent de Besche, in 1910, were also unsuccessful in their search. Freund, in 1928, reported 2 cases and found no proof that the etiologic agent was demonstrable in the fluid of the zoster vesicle.

CUTANEOUS LESIONS

Head showed that an unruptured cutaneous vesicle was divided by small septums, extending from the roof to the floor and that in the floor were masses of round cells. The external covering of the vesicle consisted of the non-nucleated cells which made up the epidermis. Head stated

the belief that the septums were due to partially raised epithelial cells which retained their attachment to the roof and the floor. The vesicle was a cavity with incomplete partitions, formed by altered epithelial cells attached to the roof. It contained epithelial cells of all ages, which showed a nucleus, and many leukocytes derived from the vessels. The papillae below the vesicles were engorged with blood and contained many leukocytes.

When a vesicle is changing to a pustule, the cells in the septums increase and push apart the epithelial cells on the floor of the vesicle. The cells are often so enlarged as to contain several nuclei and surround the nerve trunks and press on the nerve covering. This causes the fine nerve twigs in the deeper layers of the corium to show swelling of the neurilemma, with degenerated myelin sheath, and results in disappearance of the white substance of Schwann, leaving the axis-cylinder swollen and bare. The larger branches also show conspicuous degenerative changes. Oliver stated that these changes produce the severe attacks of neuralgia which precede or accompany the eruption.

The changes in the skin are usually found in the rete layer of the epidermis. The epithelial cells assume various shapes as a result of traction: these are degenerated cells. In these cells, in and around the vesicles, are found inclusion bodies, resembling protozoa, at first thought to represent parasitic cell inclusions but now considered merely as degenerative changes. Sections of the skin through lesions show that the vessels are dilated and surrounded by lymphocytes and leukocytes. The vessel walls are edematous, and the internal cells of the walls are swollen.

OPTIC NERVE, RETINA AND CHOROID

In some cases the optic nerve has been involved during the process, and this may be due to the fact that the organism may spread locally from the posterior, or gasserian, ganglion to adjoining structures. The optic nerve and the gasserian ganglion are very close together, and this may account for the presence of blindness in some cases, the result either of the toxin or of the specific virus involving nearby structures. Wyss, in 1871, reported that the choroid showed extravasation of blood and leukocytes. Meller, in 1920, found small foci of round cells around the vessels in the choroid, which were confined almost entirely to the middle and outer layers. The outer layers of the retina were normal; the stratum fibers of optic nerve were atrophic, and in some places perivascular infiltration was apparent. Head and Campbell did not find the retina and choroid involved in any of their cases, but in 1 case the optic papilla showed edema and contained a few round cells. The optic nerve showed destruction of fibrils of the medullary sheaths of the nerve fibers. In some cases the ciliary nerves were surrounded by a sheath of mononuclear cells. Gilbert observed that horizontal sections through the eye at the level of the optic nerve showed pronounced perineural infiltrations. The sections, which included ciliary nerves in their oblique course through the sclera or between the sclera and the choroid, showed some marked inflammatory changes in and around the nerves. The nerves during their oblique course in the sclera were cuffed with round cells. When one of the nerves lay close to the choroid, the inflammation involved the choroid, more specifically the suprachoroid and the layer of large vessels, where the infiltration became primarily intervascular, rather than perivascular. Accumulations of round cells occurred in sections of the ciliary nerves in the upper half of the bulb, posterior to the ciliary processes. Gardilčić, in 1937, noted similar changes. Kreibig, in 1938, found that the posterior ciliary nerves presented, in part, similar conspicious alterations, necrosis and areas of infiltration. These investigators observed perineuritis infiltrates and infiltrates in the nerve itself, with small hemorrhages. Small nerve bundles, likewise densely infiltrated, were traceable from the region of entrance of the optic nerve to the ciliary body. Numerous perivascular infiltrates, unassociated with nerve fibers, were also observed. Meller was able to follow the perineuritic infiltrations into the interior of the eye, an observation which would explain the many infiltrations of the sclera, choroid, cornea and iris, with resulting necrosis.

IRIS AND CILIARY BODY

Wyss, in 1871, reported that the iris showed numerous lymphocytes on its anterior surface. Head and Campbell found that the iris was necrosed, as well as nearby portions of the ciliary body and the sclera. Meller, in 1920, observed that the iris was necrotic, with irregular scattering of pigment, and that the ciliary body showed many foci of round cells in atrophic muscle fibers. The vessel walls showed hyaline degeneration and were thickened. Kreibig found that the iris exhibited near the root two small areas of necrosis. The ciliary body was found, to a large extent, to be necrotic and to be surrounded by a dense wall of infiltrate.

GLAUCOMA

Disturbances of ocular tension in cases of herpes zoster have for several years been the ob-

ject of investigations, the results of which have added to knowledge of the physiopathology of the sympathetic nervous system. The pathologic nature of the glaucomatous complications is obscure, although several hypotheses have been considered. Some workers believe that the inflammatory process from the gasserian ganglion extends along the nerves to the globe of the eye itself. Others believe that the acute form of glaucoma is the result of a disturbance of the sympathetic nervous system. While the action of the sympathetic nervous system in the control of ocular tension is not as yet clearly understood, the glaucoma which supervenes in cases of ophthalmic zoster ordinarily is related to sympathetic excitation. However, it appears that regulation of ocular tension is not controlled by the sympathetic system exclusively, and it is possible that the zoster virus may act on tension of the eye by way of other nerve filaments. Experimental retrogasserian neurotomy is accompanied with diminution of ocular tension. Excitation of the root of the trigeminus immediately beyond the protuberance raises ocular tension, while its section lowers the tension. As a result, zoster should be accompanied, rather, with diminution of tension.

CORNEA

Biozzi expressed the opinion that trophic disturbances in the cornea arise through a nerve filament which connects the sphenopalatine with the ciliary ganglion, but this filament is not constant, a fact which explains why the cornea does not in all cases participate in the sphenopalatine syndrome. Head and Campbell stated that the corneal lesion was a subepithelial infiltration in the substantia propria, occurring around the terminal nerve fibers, which resulted in vesicles and secondary infection, or it might lead to keratitis profunda, iridocyclitis, increase in tension, optic nerve atrophy and motor paralysis. Reiser showed that after destruction of the gasserian ganglion the first sign of degeneration of corneal nerves appeared in twenty-four hours. After sixty hours hardly a single fiber of the thick corneal nerve bundles was intact. The signs of degeneration lessened toward the periphery of the nerve elements, while the terminal nerve fibers showed no signs whatever of degeneration. This power of resistance is due to the syncytial structures and has been known for some time. The few fibers which enter the cornea from the conjunctiva suffice to provide the nerve supply to the corneal cells by way of the terminal reticulum, which remains intact after section of the afferent nerves.

One is accustomed to think of sensory nerves as conveying only afferent impulses. Broadbent, in 1866, stated that in cases of herpes zoster the sensory nerves may conduct influences or impressions from, as well as toward, the nerve centers. Parsons expressed the belief that the transmission of impulses also may proceed in the opposite direction. Bayliss called these efferent impulses in afferent nerves antidromic impulses. He suggested the term "antidromic" for the process by which nerve fibers convey impulses in a direction opposite that assumed by the Bell-Majendie law when such impulses produce effects in the organs of origin of such fibers, that is, when afferent fibers excited at their ends, in the central nervous system, produce vascular dilation at their peripheral ends, in the body tissues. These posterior root fibers are no doubt capable of carrying impulses in both directions—afferent sensory impulses from the periphery to the central nervous system, and efferent vasodilator impulses from the central nervous system to the periphery.

Bruce carried out a series of experiments to show that these sensory fibers must bifurcate at their extremities at the periphery of the body, one branch ending in the sensory end organs in the skin and the other ending in the vessels. The former carries sensory impulses centralward, and the latter carries vasodilator impulses to the periphery. The common stem carries impulses in an ascending and a descending direction. If the cells of the posterior root ganglion are irritated, they will be capable of originating impulses which pass in two directions, one centralward, causing the pain, and the other peripherally, along fibers to the bifurcation, from which a twig passes to a vessel and produces dilation. Severe involvement of the ganglion gives rise to extensive eruption, and smaller lesions are associated with smaller eruptions. Teague, Goodpasture and Lipschütz stated the belief that the virus followed the nerve and penetrated the intervertebral ganglion and that it must have traversed the same route in an opposite direction in order to produce herpes zoster in the corresponding cutaneous region. This assumption they proved experimentally. Groups of vesicular elements, confined to one side of the trunk, made their appearance in guinea pigs and rabbits in consequence of the introduction of virus at one point of the corresponding region. In forty-eight hours groups of vesicles formed at a distance in the ventral and in the dorsal region but never extended beyond the median line. These lesions exhibited all the characteristics and distribution of herpes zoster.

ADJACENT GANGLIONS

Although the specific inflammation attacks chiefly one sensory ganglion, the adjacent ganglions may not always escape involvement. This explains those cases in which the eruption is in the zone of one ganglion and complications occur which can be attributed to involvement of other ganglions. Multiple involvement of these ganglions is not infrequent, thus producing a variety of clinical combinations. From considerations of cases, the symptoms of herpes zoster ophthalmicus of the face, neck, ear, mouth, eye and nose may occur together in almost every possible combination.

SPINAL FLUID AND BLOOD

In cases of herpes zoster ophthalmicus, the cerebrospinal fluid is modified, and this is not surprising, after inflammatory changes and degeneration in the posterior roots and posterior columns of the cord have taken place. The cul-de-sacs of the pia-arachnoid bathe the gasserian ganglion, and the inflammatory ganglionic process may, according to its intensity, provoke reaction in the spinal fluid, causing lymphocytosis and albuminosis. Brown and Dujardin reported on a study of the cellular elements in the spinal fluid in 42 cases, with inconstant results. In the majority of cases a lymphocytosis occurred, which showed no relation to the intensity of the eruption. In the majority of cases there was a slight increase in the albumin, and in 1 case there was an increase in the globulin content. Similar studies by numerous investigators—Corson and Knowles, Hunt, Achard, Jacquet and Bariéty, Touraine and Baumgartner, Chauffard and Rendu and others—have been described in the literature. Aubaret and Mastier found an increase of tension in the spinal fluid with the manometer of Claude, as did Rollet and Colrat. Some authors have described a reduction of tension.

Glaubersohn and Rabinowicz found, in most cases, a slight decrease in neutrophils and a pronounced increase in lymphocytes. They noted leukocytosis from the first to the fifth day, with the peak on the third day. From the fifth to the eighth day, there was a normal white cell count, or leukopenia, with polymorphonuclear leukocytes predominating and decrease of eosinophils, was present. On the eighth to the twelfth day, during the stage of drying of the vesicles, a leukocytosis, often with an increase of eosinophils, was noted. Keining and Steiger-Kazal made similar observations.

PROGNOSIS

In consideration of ocular complications which may develop during the eruption or afterward, the prognosis with respect to vision is reserved. It requires careful observation of the patient long after the disappearance of the zoster for the purpose of detection of the disturbances of corneal sensitivity. The prognosis in cases of corneal ulceration may be serious, as corneal opacity may result, in whole or in part, and may become permanent, with serious loss of vision unless requisite precautions have been instituted. When the eye becomes inflamed with the appearance of the cutaneous eruption the cornea is usually severely affected and gives rise to various ocular pictures; but, as a rule, when the cornea does not become inflamed until the termination of the attack, the symptoms are less severe. Corneal ulcerations may become secondarily infected, terminating in iridocyclitis, glaucoma or perforation. Certain lesions may appear in the absence of any superficial lesions, such as primary iritis, keratitis or glaucoma. While ocular lesions are most frequently benign, they may suddenly become grave. The prognosis is grave when iritis develops, for the eye may continue to be irritable and subject to high tension, with glaucoma developing. The attack may last from a few weeks to several months. Severe neuralgic pains with anesthesia may persist, and the exhaustion subsequent on continual pain may be a serious factor. Violent delirium has been known to occur, and suicide has been reported in some cases.

Aside from the serious risks which optic neuritis may offer for function of the eye, it involves an unfavorable prognosis for the future. Only rarely does visual function recover even a fraction of its normal integrity. When loss of the eye is not complete, vision is always impaired.

A reserved prognosis is necessary when ophthalmoplegic symptoms which do not recede completely are observed during the course of the eruption. All paralytic phenomena constitute a highly important element in prognosis from the viewpoint of a nervous disturbance, which may arise in a more or less remote future. Muscular complications may be divided into two categories: those which tend toward complete recovery, and those which are followed by more or less permanent disturbances, after some improvement. In some cases a certain degree of paresis may become permanent. This entails a hazard to future motility and may occasion subsequently even graver disturbances, which may prove fatal.

DIAGNOSIS

The diagnosis of herpes zoster ophthalmicus is based on symptoms and on the evolution of the disease. Sometimes the sequelae render possible a late diagnosis. As a rule, there is no confusion in the diagnosis provided that a thorough examination of the functional state of the eye is conducted in every instance of a zoster eruption. A careful test of visual acuity should be instituted first, and afterward tests for binocular vision and motility should be performed, whereupon the existence of a slight degree of diplopia or of a strabismic deviation will be readily recognized.

Herpes zoster ophthalmicus has been mistaken for erysipelas, supraorbital neuralgia, disease of the frontal sinus, migraine headache, eczema, cyclitis, dacryocystitis, impetigo, sinus thrombosis, cerebral tumor, meningitis and herpes simplex. In erysipelas, there are large bullae, and the skin is greatly swollen. The eruption is not limited to the midline; it affects both sides and assumes the aspect of the wings of a butterfly. The fever is higher, and the pain is absent. The condition may be confused with herpes simplex on account of the localization of the latter and the nervous disturbances associated with it. Herpes simplex is, however, not accompanied with neuralgic pains. Impetigo exhibits its characteristic crusts and may be localized in any part of the face. In some cases, in which an associated unilateral paralysis of the ocular muscles exists, aseptic thrombosis in the cavernous sinus must be considered. In a case of this type, there are marked chemosis, and frequently exophthalmos, and the symptoms are often bilateral. Thrombosis of the lateral sinus can usually be eliminated by roentgenograms. Slow hemorrhage from an aneurysm of the internal carotid artery or from the circle of Willis gives a similar picture. Cerebral tumor can usually be eliminated by the history of sudden onset, negative roentgenograms and absence of signs of intracranial pressure. The fifth nerve sends a branch to the meninges, and often severe local meningitis may accompany the disease.

TREATMENT

In an attempt to determine what course of treatment should be followed in the future in cases of ophthalmic zoster, the results and types of therapy employed in past years have been analyzed. A specific treatment for herpes zoster is not available, and one must choose from a wide variety of therapeutic measures. A vast number of remedies have been suggested for this disease, but no one of them has been successful in all cases. The treatment of zoster has been largely symptomatic and has been directed chiefly to the relief of pain. The general treatment consists of rest in bed, light diet, sedatives and supportive measures. Salicylates, quinine, bromide, iodides, barbiturates and arsenic have been used as alteratives, with beneficial effect.

Early protection of the cornea prevents its superficial involvement in many cases. The cornea can often be protected by the use of ointments, and atropine is often indicated. If ulcers develop and are deep, suturing of the lids may be necessary. Rea advised bandaging the eye from the start, for a period of several weeks or months. He recommended daily irrigations with a mild solution of boric acid and use of a mild ointment between the lids.

If hypertonia is present, miotics are indicated in some cases. The use of warm compresses is often advisable. Mild protein silver U. S. P., neo-silvol, ethylmorphine hydrochloride, phenacaine hydrochloride and ethylhydrocupreine hydrochloride have all been used, with benefit in some cases. Pierron advised touching up the ulcers of the cornea with 1 : 1,000 solution of methylthionine hydrochloride or tincture of iodine and applying ointment of ichthammol, 1 : 200, between the lids. Ammoniated mercury ointment and ointment of scarlet red have also been recommended by some authors. Burwell, in1922, advised the use of subconjunctival injections of isotonic solution of sodium chloride and an occasional injection of 1 per cent guaiacol and ethylmorphine hydrochloride if corneal lesions were present.

Many types of treatment have been advised for the cutaneous lesions. Some authors prefer various powders; others use oils to prevent drying of the secretions. Painting of the vesicles with collodion has been advised, but it may increase the pain temporarily by contracting the skin in the vicinity. Fox, in 1922, advised a mixture containing liquid petrolatum. Others have recommended the use of 5 per cent silver nitrate, a weak solution of iodine, a weak solution of phenol, tincture of benzoin, hydrogen peroxide or sterile olive oil. Employment of pure alcohol was advised by Reynolds. Bayer painted the vesicles with ointment of ichthammol. Cocaine and zinc oxide ointment have been used occasionally, with success. Astringent powders have been advised by Morax, Fuchs and Rollet. Oils and petroleum were advised by Doggart, Darier and de Schweinitz. Some physicians apply zinc stearate, starch and talc over the surface of the skin each day, and others prefer bismuth tribromphenate. Calamine lotion; 2 per cent gentian violet medicinal; diluted solution of lead

subacetate and tincture of opium U. S. P.; potassium permanganate, 1:4,000, and various other lotions and powders have been tried.

In 1938 Hollander introduced the treatment of anesthetization of hyperesthetic areas of the skin for the relief of pain. These areas are located about the papules and vesicles of the herpetic rash. In all his cases the pain did not return, either during or after the resolution of the lesions. When every hyperesthetic zone is anesthetized, the pain is completely relieved. He employed 5 per cent benzyl alcohol, 3 per cent ethyl aminobenzoate and 1 per cent phenol in expressed oil of almond. He injected 0.5 cc. of the preparation per square inch of surface, just under the corium. Secunda, Wolf and Price treated several patients with a subcutaneous injection of 1 to 2 per cent solution of procaine hydrochloride under the inflammatory tissue, with complete relief of pain, and in most cases the relief was permanent. The clinical course of the cutaneous lesions was not affected. Rosenak reported relief of pain and regression of vesicles after intervertebral and paravertebral injections of a 0.5 per cent aqueous solution of procaine hydrochloride. Pillsbury and Fondé advised the use of an ointment containing 1 per cent nupercaine hydrochloride in small amounts, rubbed into the skin.

The beneficial effects of thiamine hydrochloride in cases of neuritis and its value in prevention of certain degenerative changes are acknowledged, and as the prominent feature of herpes zoster is neuritis and a degenerative change, many investigators have used it, with good results. Pain is often definitely relieved. Nitzulescu and Triandaf, Carlevaro, Vorhaus and Viallefont reported good results with thiamine hydrochloride, aminothionine and thiosinamine. Thiamine hydrochloride, 5 to 10 mg., is often injected subcutaneously daily for six days. Goodman treated 5 patients with thiamine hydrochloride, with excellent results. He used six or seven subcutaneous injections of 3,000 units. The injections were administered daily. He claimed that the pain was relieved promptly and the lesions of the skin cleared up earlier. Ascorbic acid has been used by some investigators. Daïnow, in 1936, claimed to obtain a more rapid evolution of the disease through repeated intravenous injections of from 10 to 15 cc. of the substance. Some patients received as high as twenty-five injections. Its influence is assumed to be due to the fact that vitamin C acts directly on the hypothetic virus of zoster.

Vendel, in 1923, was one of the first to enumerate the benefits of solution of posterior pituitary U. S. P. (surgical) for herpes zoster. He advised daily injections of 0.5 to 1 cc. Sidlick advised two injections of the substance, a day apart. Numerous investigators have reported good results with this treatment, among them, Somers and Pouppirt, Gifford, and Niles. The action of solution of posterior pituitary is directed against the symptom of pain, but it has no effect on the course of the disease. This treatment is contraindicated in cases of hypertension, increased intracranial pressure or pregnancy.

Rollet, LaChaise, Pierron, Badeaux and Stumpf reported good results with radiotherapy for the relief of the neuralgia. Lane recommended radium and reported its use in 5 cases of herpes zoster, with good results.

Heavy doses of roentgen rays are used to relieve pain and reduce the intraocular tension in cases of herpes zoster. High voltage roentgen therapy has been advised by Schamberg; Secunda, Wolf and Price; Darier; Milian; Meller; Keichline; Lloyd; Pardee, Pendergrass, and others. Stephenson, in 1928, noted the early relief of pain with roentgen rays, and he claimed that it shortened the course of the disease. Foveau de Courmelles also reported excellent results with this treatment in the relief of pain following ophthalmic zoster. He expressed the belief that the doses applied should differ according to the individual patient and that a tentative dosage is required for each patient. He stated that investigation of the conditions of the skin, digestive apparatus and cutaneous reactions is necessary. With these data, the operator is able to determine whether to apply soft rays or hard, penetrating rays. Filtration is essential and should be adapted to each patient. He claimed to have had successful results in 80 per cent of cases of herpes zoster, relieving pain and neuralgia in a short time, as well as hastening recovery. Badeaux, in 1935, reported excellent results with roentgen therapy in 4 cases of ophthalmic zoster. The pain ceased in twenty-four hours, and in four or five days the cutaneous lesions were dry and the corneal ulcers had healed. The factors used were as follows: 110 kilovolt peaks; 5 milliamperes intensity; 4 or 5 mm. aluminum filter; exposure time of four to six minutes, varying with the region or the case, and anode-skin distance of 10 inches (25.4 cm.). Roentgen irradiation for postzoster neuritis and irradiation of the ganglions have reduced the intensity of the disease and relieved pain. Vignal was one of the first to use roentgen radiation for the relief of pain of herpes zoster, and he expressed the belief that its value lay in the specific effect on resorption of a round cell infiltrate in the spinal ganglions and the posterior spinal nerve roots.

High frequency currents have proved serviceable. Buckley, in 1874, was the first to use galvanic current in cases of this disease for relief of pain. W. O. Moore later reported good results, as did Sutton, using 5 milliamperes in the treatment. Tsiekhanovich, in 1897, and Menacho, in 1902, claimed good results with electrotherapy. Letulle, in 1882, reported successful use of the faradic current. Violet radiation has been advocated by some because it is rapid in action and effective against pain and its use avoids indelible scars.

Grüter used short wave rays from twenty to twenty-five minutes, with success, in a case of herpes zoster. These rays produced edema of the cornea and iris, but the herpetic infiltration in the parenchyma cleared rapidly. No burns of ocular tissue were observed. He concluded that the biologic action of the rays was due to the intense warmth penetrating into the depth of the tissues, by which the growth of bacteria was stopped, and to the intense increase in the circulation of lymph. The latter was manifested in a rather protracted edema in the corneal tissues.

Falcão, in 1927, reported excellent results with rays of a Hanau lamp, at a distance of 60 cm. The pain disappeared after two treatments, and after seven applications the eruption had healel, without trace of any scars. Lloyd advised the use of radiant heat, an infra-red lamp or Thermolite. Jacobson, in 1926, obtained good results with the daily use of a 1,000 watt red globe for twenty minutes. A few such applications healed the lesions and removed the pain. L. Coppez advised diathermy for herpes zoster ophthalmicus. This consisted in the employment of currents of low tension and high frequency. This treatment was used in 4 cases, with gratifying results. Ebert, in 1941, also reported good results with diathermy for the relief of pain. MacNab and Ettles used ionic medication in several cases, with benefit. The neuralgic pain and disturbed sensibility disappeared almost at once.

Marlow observed 4 cases in which treatment consisted of intramuscular injections of arsphenamine (0.6 Gm.) and mentioned 5 other cases reported by Milian in which this therapy was used, with striking results. In twenty-four hours the pain was much diminished, and in twenty-four hours more it was completely relieved. In each case the eruption of the skin cleared within a few days. All showed large areas of epithelial disturbance of the cornea, which healed with an insignificant scar and with little visual loss. Gebb, as did Yanes, reported good results with neoarsphenamine, which brought about immediate improvement in the cutaneous lesions but had no effect on the ulcerations. Agnello claimed similar results. Römer and Zangger each recommended arsenical preparations for internal use during the course of the disease. Elliot claimed that solution of arsenic and mercuric iodides U. S. P., 10 minims (0.62 cc.), three times daily in water after meals, was a specific for pain in this disease and helped very much the clinical course. Torres, in 1936, reported good results with injection of 3 cc. of Arsaminal (arsphenamine), which gave marked relief in twenty-four hours. He concluded this preparation of arsphenamine represented an extraordinarily efficacious therapeutic agent for this disease. Mildenberger, in 1937, used intravenous doses of Atophanyl (product containing cincophen sodium, sodium salicylate and paraaminobenzoyl diethyl aminoethanol), with excellent results. Endoarsen (a product containing a cacodylate combined with mercury and iodide) also has been recommended. Fournier reported good results with intravenous injections of iodobenzomethylformine. The pain disappeared in twenty-four hours. Treatments were given daily for four days, and by this time the lesions of the skin had largely faded.

Bénard and Joltrain, in 1927, reported good results with the use of intravenous injections of the sulfurous and isotonic water from springs at Uriage, France; 10 cc. doses were given.

Richman, Beam and Lindberg, and Walker and Walker reported successful treatment with injections of 5,000 units of diphtheria antitoxin given intramuscularly. Two such treatments were given, as a rule, during forty-eight hours. They claimed that the subjective and objective symptoms abated almost at once. Berrisford, in 1935, reported 4 cases, in which he gave three intravenous injections of triple typhoid vaccine during the course of seven days. He described glowing results with this treatment.

Phillips and Morginson, in 1932, advocated the use of sodium iodide. The drug was used intravenously, in 2 Gm. or 31 grain doses on alternate days, for from five to seven injections, or until relief was obtained. Pain usually disappeared after the first treatment. Lockwood, Ruggles and Powell reported good results with this type of treatment. Sindhu used the same treatment combined with 1 cc. of solution of posterior pituitary U. S. P. given subcutaneously, the treatment being repeated in two days. Stastnik treated 5 patients, in 1935, with a 20 per cent solution of sodium thiosulfate administered intravenously. Four to twenty injections were given, daily or every other day, depending on the severity of the ocular infection. Other authors used quinine, salicylates, theosinamine, ethyl chloride and iodine preparations. Junius

reported good results with lactic acid, which he claimed were due to its altering effect. Renard advised against the use of local treatment if there was any motor disturbance of the pupil or oculomotor paralysis, but urged mercurial therapy.

Grandi, in 1937, used intramuscular injections of Protinal for pain. J. Rollet and Parthiot, and Sarkovski recommended injections of procaine along the course of the nerve, while Rasquin, Michelsen, Vincent, W. Harris and Frazier advised injection of alcohol into the nerve. Johannson, in 1936, used Impletol (a combination of procaine hydrochloride and caffeine) to relieve pain, with satisfactory results. Duke, in 1924, advised use of epinephrine subcutaneously, 0.5 cc. every five minutes until the patient was relieved or until a tremor appeared. This had no effect on the cutaneous lesions. If the drug was given in adequate doses, Duke claimed that the relief of pain was prompt in 50 per cent of cases.

Francois, in 1936, used subcutaneous injections of antistaphylococcus vaccine in the vicinity of the eruption, with good results. Fouassier, in the same year, saw a case in a female who was successfully treated by intradermal injection of this vaccine. In order to prevent local and general reactions and to avoid the painful subcutaneous injections, he used 1 drop of the vaccine intradermally, in the vicinity of the largest pustule, the injection being repeated every two days and increased each time by 1 drop. Improvement was noted on the third day. The pains had disappeared and the swelling lessened. At the time of the sixth injection, of 6 drops, the patient appeared cured. Four supplementary injections of 6 drops were given on alternate days. The author expressed the belief that the superiority of this treatment provided protection for the organism against infection, simultaneously with promotion of rapid and complete disappearance of pain. Godal and Magrou, in 1937, used the same treatment, with good results. From their experience with vaccinotherapy of zoster, they were of the opinion that the evolution of the disease was curtailed thereby, at least so far as acute symptoms were concerned. The pain was alleviated almost immediately, and the lesions dried up more rapidly than normally. The relief of pain preceded that of the dermatitis. They stated the opinion that the amount of vaccine should vary according to the intensity of the zoster. They thought that the action of the vaccine served to abort the zoster promptly, thus preventing the more or less grave ocular complications, which are always to be apprehended. They began treatment with 0.5 cc. of antistaphylococcus vaccine injected into the forearm. On the following day they gave 0.75 cc., and then 1 cc. for the next four days.

In patients who suffer from persistent pains, accompanied with keratitis, it is often necessary to protect the cornea by a median tarsorrhaphy, not only during the course of zoster but even for many years afterward. Long external blepharorrhaphy is successful in many cases. Cross, in 1918, performed pericorneal neurotomy in a patient for relief of constant pain and corneal ulcer. Relief of pain was immediate, and the ulcer healed in seventy-two hours. Lodge and Lodge sutured the lids to relieve pain, and corneal ulcers were checked and repair followed rapidly. Badot recommended removal of the central portion of the ophthalmic branch of the trigeminus nerve in cases of severe zoster. Peet, in 1929, sectioned the sensory root of the gasserian ganglion in 2 cases of postherpetic trigeminal neuralgia.

Bryan, in 1923, reported a case of zoster in a male involving the first and second branches of the nerve. Pain in the eye was relieved by cocainization of the nasal ganglion; and to relieve the pain in the distribution of the supraorbital and frontal nerves, the ophthalmic division of the fifth nerve was reached with cocaine through the sphenoid ostium. This gave instant relief, and some time later the same procedure was repeated, with success. When the procedure was repeated the second time, the ophthalmic division was cocainized as before, but this did not relieve the pain in the eye until the nasal ganglion was cocainized. The nasal ganglion is the sympathetic ganglion of the maxillary division, corresponding to the ciliary ganglion of the ophthalmic division. Sicard and Robineau, in 1922, reported 3 cases in which persistent neuralgic pain continued for years after the disease had subsided. Gasserectomy was performed in these cases, with destruction of the root by avulsion. The authors felt that this was necessary because herpes zoster involved not only the ganglion and root but other deep centers and that avulsion of the root was much more efficacious. Complete cure resulted in all 3 cases. Wood, in 1929, described a case of zoster in a woman, who continued to have intense and constant pain on the left side of the face. He injected procaine into the supraorbital nerve just back of the foramen. Complete relief of pain followed. For this reason, he advised division of the supraorbital nerve just behind the foramen, pulling out as much of the proximal end of the nerve as possible to delay union. Cushing, in 1920, treated 3 patients with severe zoster neuralgia. In 1 trigeminal neurectomy was done, and in the other 2 the supraorbital nerve was avulsed. Halphen published a report of a case

with vesicular eruption of the left side of the face, edematous lids and violent pains. In view of the intensity and the persistence of the pain, and with knowledge of the theory of the sympathetic origin of facial pain, anesthesia of the sphenopalatine ganglion was induced, with injection of alcohol via the nasal route. The patient experienced immediate relief of pain. The herpetic vesicles dried up on the fourth day, and crusts fell off on the eighth day. Anesthesia of the sympathetic and of the superior maxillary nerve can be obtained by injection behind the tip of the middle turbinate bone. He asserted that disappearance of pain was due to the irritation of the ophthalmic nerve. This was explained on the assumption that the alcohol paralyzed the fibers of the sympathetic system, since the anesthesia affected only the fibers of the superior maxillary nerve, or that relief from pain was due to trigeminal anesthesia, entailing a vasomotor alteration locally or remotely in the region of the sympathetic, with relief of pain from this vasomotor alteration, such as results from action on the sphenopalatine ganglion. In many cases of trigeminal neuralgia, Frazier found that cocainization of the sphenopalatine ganglion controlled pain almost immediately. He concluded that the treatment paralyzed the sympathetic fibers. Kowler, in 1937, reported good results in 2 cases by painting the entire middle turbinate with a solution of Bonain, phenolized cocaine.

Freidenwald, in 1929, was the first to use convalescent serum in this disease, with immediate relief of pain. The cutaneous rash rapidly subsided. McDonald, and Walker and Walker reported good results with this serum. Gundersen, in 1940, gave detailed observations and reported on 91 patients so treated. Sixty-one (66 per cent) had ocular infection, and of these, 82 per cent had useful vision. Of his patients not treated with any specific remedy, 40 per cent had useful vision. He claimed that good results may be expected if treatment is given before the ocular infection is established, especially during the first few days following the eruption. The treatment not only relieved the pain with startling suddenness but cut short the course of the disease. For those who prefer this type of treatment, convalescent blood or serum, for this disease, blood banks should be found to be useful. Cornil and Blanc, in 1931, reported on treatment of a patient with 20 cc. of blood taken from a patient convalescing from zoster. Complete relief of pain followed at once.

The practice of autohemotherapy of dermatoses dates from 1913. It was preceded during three years by hemoserotherapy, consisting in treatment of the patient with serum of a healthy person. In 1913, Ravault simplified the method of autoserotherapy by utilizing whole blood of the patient from a vein in the elbow. This was reinjected at once under the skin of the abdomen or into the muscles of the buttock. This treatment was used for various cutaneous diseases, including herpes zoster. Spillman and Raspiller, in 1923, used this method successfully in treatment of zoster, as did Pillsbury and Fondé, Parisot and Simonin, Avalos, Drouet and Vernier, Wintzer, Beeson, Wagner, Resmond, Terrien, Barrio de Medina, Barksdale, Worms, Sourdille and Legrand, and Francois. This treatment consists in withdrawal of 5 to 20 cc. of blood and its injection into the patient's gluteal muscles. The amount of blood varies. Children are given half of the amount for adults. There are no after-effects except slight pain at the site of injection, and in some cases a mild febrile reaction ensues. As a rule, two or three injections suffice. There are usually rapid relief of pain and healing of the vesicles. Drouet used this method in 8 cases of ophthalmic zoster, with excellent results. Even with the initial injections, almost complete disappearance of pain resulted, with rapid attenuation of eruptive symptoms. The vesicles became desiccated in two or three days, and the zoster was cured in ten days. The neuralgias were never observed to return after the treatment. In 1 of his cases there were three recurrences without specific treatment, but after the autohemotherapy the symptoms disappeared and there were no more recurrences. Sédan gave eight injections to each patient. The first injection was of 5 cc.; the second and third, of 10 cc. each; the fourth of 15 cc.; the fifth, of 20 cc., and the sixth, seventh and eighth, of 30 cc. each. All treatments were given at intervals of three days. Sédan concluded that a subnormal tension of the globe almost always became elevated at the end of five or six hours but that on the following day it declined to a level lower than that noted prior to injection. Although the mechanism of the action is still obscure, it is probably that of a protein shock produced by albuminoid substances of the blood. Wintzer asserted that the action was based on sensibilization and desensibilization. Paillard stated the belief that the blood was slowly absorbed by the lymphatics and produced a favorable defense reaction. Spillman and Raspiller expressed the belief that the treatment could be classed with the methods of nonspecific desensibilization.

I have used this method with success in several cases. The procedure is simple, and pain is

quickly relieved. The eruption responds to treatment, and few injections are necessary. Early treatment prevents severe pain and ocular complications. It has no effect on well established uveitis, due to zoster, but it may prevent development of new uveal foci of infection. During the eruptive period, when palpebral edema is present, local treatment should be restricted to moist compresses to avoid accumulation of secretion. In some cases the lesions of the skin are best treated with a mild astringent lotion, such as solution of calcium hydroxide, twice daily. Olive oil is often of benefit in cleansing the skin. At times a protective dressing is necessary. Cold air and drafts should be avoided. Ten grains (0.65 Gm.) of acetylsalicylic acid every four hours will usually relieve pain, but in some cases morphine is necessary. Atropine and ethylmorphine hydrochloride may be indicated if the cornea or the iris is involved. Tetracaine or some other useful local anesthetic may be advisable for the relief of pain in the cornea or the conjunctiva. Mild protein silver, neo-silvol or some other preparation of silver is often found to be useful.

As soon as swelling of the lids subsides and the affected eye can be opened, an examination for corneal anesthesia should be conducted, and afterward tests for the extrinsic and intrinsic motility of the globe should be made. While corneal anesthesia persists, the eye should be covered with an occlusion bandage, and if anesthesia or corneal ulceration persists, tarsorrhaphy should be performed and the suture maintained for several weeks.

Even after the disappearance of zoster, patients should remain under observation, since corneal disturbances or increase of tension may manifest itself at a late date and disturbance of sensibility may persist for a long time, and perhaps indefinitely.

CONCLUSIONS

The severity and duration of the disease vary. Complete recovery may follow in a few weeks, or the condition may drag on for months in spite of treatment. In all cases of herpes zoster there is a morbid condition of the sensory nerves supplying the affected area, and the type and localization of the changes are variable. Specific clinical manifestations appear to be the result of some form of irritative reaction to the ganglion or nerve, whether due to infection, trauma or intoxication. It may be that predisposing factors favor the establishment of herpes zoster, such as cold, injury, head colds, specific infections or sinus or dental disease. The process may start in various portions of the nerve, the ganglion or the peripheral branches, and even in the contiguous ganglions connected with the nerve, such as the sphenopalatine ganglion in the case of the fifth nerve.

In a vast majority of cases of ophthalmic zoster the disease is secondary or symptomatic. The causes and character of the basic disturbance vary. Different kinds of systemic disease, even latent ones, may result in herpes zoster ophthalmicus. The basic disease may even run its course, leaving only a predisposition to nervous disturbance or nervous irritability. Levaditi stated his belief that various causes were provocative agents, forming a place of least resistance on which the latent virus of zoster might act.

It is not known whether in cases of herpes zoster which occurs coincidentally with other infectious diseases the zoster is actually produced by the same etiologic agent or whether it is produced by its own virus, the infection being facilitated by general lowering of bodily resistance.

According to some authorities, spread of the virus occurs through the cerebrospinal fluid, and thus it is explained how the more superficial fibers originating from specific sensory nerves or fibers destined for certain muscles are first affected in certain ganglions or nerve trunks. Proponents of this theory regard ophthalmic zoster as a manifestation of various infectious processes, which are spread by way of the spinal fluid, and so account for its selective action on particular sensory filaments and muscles, whose nerve fibers are superficially located in the nerve trunk, which is bathed by the fluid. Goeckerman and Wilhelm stated the belief that the same lesion might result from several causes, including trauma, hemorrhage and focal infection. They were not convinced that a single agent caused the disease.

There may be a form of zoster not induced by neuritis or inflammation of the nerve ganglions but due to a disturbance in the higher sensory centers of the trigeminus in the medulla oblongata (bulbar type), which has to date been described in 1 case, in which malaria was the cause, by Düring and Huber. In this case, they concluded that the seat of trouble was a paralysis of the bulbar nuclei, probably located where the centers of the sensory trigeminus and the vagus nerve and the posterior horns of the second and third cervical segments lie close together. They stated the belief that in this case the zoster was due to a vascular alteration after malaria, following endothelial proliferation and partial occlusion of vessels.

The traumatic origin of the disease has never been scientifically demonstrated, although it is possible that there is a connection between corneal trauma and corneal herpes zoster. In these cases, it is questionable whether injury is the prime etiologic factor.

Ocular paralyses which supervene during the course of zoster are not so rare as is generally assumed, although their frequency is variously estimated by different observers. Their occurrence is independent of the intensity and distribution of the eruption. They usually occur two or three weeks after the eruption. The third nerve is most frequently involved, and the paralysis may be partial or total. It may be revealed by ptosis or mydriasis, although it must be remembered that these conditions may also be produced by inflammatory ptosis, or by alteration of the pupil due to lesions of the cornea, or by paralysis of the sympathetic fibers. It has been demonstrated by Ingvar that the fibers corresponding to the levator palpebrae and the superior rectus muscle occupy a superficial situation in the dorsal part of the nerve trunk of the fifth nerve, while those corresponding to the inferior oblique muscle are also situated superficially but in the ventral part. Therefore, these muscles would be more readily affected by pathogenic agents attacking the nerve trunks externally, as in instances of basal meningitis or in cases in which the infectious agent is spread by the spinal fluid.

Combinations of paralysis of the trochlear and the abducens nerve sometimes occur. Only 2 cases of bilateral paralysis have been noted in the literature; 1 of the sixth nerve, reported by De River, in 1926, and the other, of the third nerve, reported by Gallois, in 1924. Paralysis of the motor nerves of the eye may be due to extension of the disease to the trigeminus and then to the motor nerves by way of the sensory ramifications, which the first branch of the fifth nerve sends out to all motor nerves of the eye, before entering the orbit. Vernon stated the belief that paralysis of the ocular muscles was due to the same influence as the herpes, and Wyss was inclined to refer the muscular paralysis to myositis. I found 242 cases of paralysis of the ocular muscles in the literature.

The lacrimal gland reveals its participation in the disorder by disturbances of nerves controlling the secretion of tears, which cause abundant transitory lacrimation. Terrien said that the keratitis was favored by the abolition of continuous lacrimation, which he thought depended on the facial nerve, and stated that when the petrous bone was removed at the same time as the ganglion, the secretion of tears disappeared and the cornea was altered. But if the ganglion was sectioned without cutting out the petrous bone, the secretion of tears was preserved.

The epithelium of the cornea is soft, delicate and loosely attached to Bowman's membrane. It is liable to injury, has a precarious nutrition and retains its health mainly through its sensitiveness. The rich nerve supply protects the cornea by the sensation of pain and by the trophic influence, the influence which the healthy nerve has on corneal nutrition. This ease of epithelial denudation is an important factor in development of corneal disorders. In herpes zoster there is corneal anesthesia, and this invites secondary infection and renders the cornea liable to injury. In addition, there may be an irritative influence passing down the nerve, causing disturbed nutrition, or the normal influence that passes along the nerve may be disturbed. In addition to the detached corneal epithelium, the small, inflamed terminal nerve fibers set up an irritative process at the periphery. In cases of corneal ulceration, the result is that characteristic of every infection of the cornea. The lesion may terminate in a scar and leave a serious diminution of vision.

The fifth nerve is similar, morphologically and physiologically, to the posterior radicle of a spinal nerve. According to Talkovskiy, it has a definite biologic arrangement in the ectodermal portion of the cornea and appears to be neurotropic for an ectodermal virus. He claimed that the development of the corneal process was explained by the morphologic character of the nerve apparatus of the cornea, the status of the nerve portions and the anatomic communications with the nerve network of the cornea.

There is always anesthesia with zoster of the skin, and usually areas of anesthesia are found on the cornea. The cornea may be hypesthetic, and some authors believe this loss of sensation underlies the corneal lesions. Experimental work has shown that in cases of section of the trigeminus in which sensibility was preserved keratitis was rare, while keratitis was present in the majority of instances in which anesthesia was absolute. The impairment of corneal sensation varies, the degree depending on the amount of damage sustained by the ganglion. Head and Campbell showed in their researches that the more severe keratitis was associated with complete destruction of nerve cells in the ganglion. Lesions of the cornea are present in 40 per cent of cases.

Various hypotheses are given to account for the optic neuritis. Included among these are reflex disturbances, particularly the anastomotic union of a filament of the ciliary nerve with the optic nerve, acompanying the central artery of

the retina. According to this theory, infection proceeding from the ganglion descends along the trunk of the ophthalmic nerve and thus reaches the optic nerve.

Iritis often manifests itself as an anterior uveitis or an iridochoroiditis and is characterized by its torpidity and by the minute percipitates on the posterior surface of the cornea. In some cases, the classic form with posterior synechias is seen. It may be associated with hypertonia, even though iritis is ordinarily associated with hypotonia. Iritis is present in about one fifth of all cases of ophthalmic zoster.

No definite etiologic factor has been found. Some kind of acute intoxication takes place, becoming localized in the ganglion and producing a toxic element that irritates the nerve ends of the part involved, causing herpes to develop. It is questionable whether the disease is due to any special etiologic factor, even though it appears contagious at times.

The cutaneous lesions may be due to products of degenerated ganglion cells conveyed along the nerve to the termination in the skin or to the exciting organism itself acting through nerve impulses on actual passage of the virus, or to the products of degenerated nerve fibers in the skin. There is selectivity, for at times the skin is not even reddened between the vesicles, and the vesicles do not appear in all parts of the skin supplied by the nerve.

Whether the disease is due to selective affinity of some virus or bacterium in a focal lesion, as claimed by Rosenow, or to the selective action of their toxins, as suggested by Mackenzie, is questionable. If one virus is responsible for so many different lesions, it is certain that it is capable of different action at various times and places. It is quite possible that the virus is liable to a variable virulence and may be inconstant in its affinity for the bipolar ganglion cells. Irritation of these cells causes the herpetic eruption, whether due to a virus or to some inflammatory process or growth. Whether it is exogenous and extends to the ganglion by way of the nerve, or whether it is endogenous and is attracted by the nerves and ganglion through increased neural irritation is not known.

Age and sex are not factors. On the basis of findings in the blood in the disease and of reports in the literature, the infection is thought to be of low virulence, and no definite conclusion can be drawn concerning the severity of the disease by examination of the blood.

The disease is often associated with dental and focal infection, but most adults have enough infection, local or general, in their systems so that an attack could occur at any time and need not appear in epidemic form. There may be a special local or general susceptibility, for not every one has the disease.

The essential cause of the disturbance is unknown, whether destruction of trophic fibers, irritation of nerve elements, injury to insensitive structures, spread of the degeneration process from nerve terminals to cells in the ganglion or a specific infection.

The pathologic process of ophthalmic zoster is a disturbance either in the gasserian ganglion or along the course of the branches of the fifth nerve or both, affecting the skin, mucous membranes and tissues supplied by these nerves. These lesions may be the result of hemorrhage in the ganglions or the sheath of the nerve, causing pressure on the nerve, or of senile degeneration or a localized inflammatory process in either the nerve or the ganglion, or a tissue reaction to various types of irritant.

Secondary degeneration may be found in the posterior columns of the cord, in the fibers of the posterior roots central to the ganglions and in the afferent fibers of peripheral nerves leading to the ganglions.

In consequence of observations and experiments by many investigators, most writers conclude that an independent pathologic entity is involved and that herpes zoster is an infectious disease of one or more spinal ganglions.

It is possible that, instead of a virus, the real nature of the cause is a change in complex protein molecules. Different strains or different arrangements of the molecule may produce various types of disease. The molecule under different degrees of body temperature may become weakened or strengthened to such an extent that it can then enter the body cells, which have been altered, and the molecule is then capable of producing a different disease, such as herpes zoster or varicella. Investigators have shown that the molecule can grow when it touches the exact kind of living cell it likes for a home. These nonliving molecules, or enzymes, merely exist, neither growing nor dying. They move about when they enter certain cells and then grow, and probably reproduce. If their structure is unchanged, they are harmless, and the way in which they are put together determines whether or not they are dangerous. The molecule is at the mercy of its environment, but on entering the right kind of cell, it reproduces itself and grows. As a result, rapid growth of molecules may cause immediate death of the cell. It was not

until the development of the electron microscope that viruses could be photographed and their structure studied, and in all probability a virus is a protein molecule.

After having made an exhaustive search of the literature, and with the aid of several translators, I find that there are approximately 2,250 cases of ophthalmic zoster reported to date. Some investigators have made a very careful study of cases and of the pathologic changes and the picture presented. Others have made only brief reports, with short case histories. In many of the cases described there was no reference to sex or age or to the eye involved. The average age was found to be 43 years; males were affected in 54 per cent of the cases; the right eye was involved in 54 per cent. The cornea was disturbed in 39 per cent and the globe affected in 49 per cent. The ocular muscles were involved during the disease in 13 per cent of cases and the facial nerve in 7 per cent. An Argyll Robertson pupil was described in 23 instances, and glaucoma appeared in the course of the disease in 65 cases. There were reports of 35 cases of episcleritis, 41 cases of recurrent ophthalmic zoster and 52 cases of the bilateral disease. All the branches of the fifth nerve were involved in 25 cases, and the first and second branches were affected in 67 cases. Retrobulbar neuritis, optic neuritis and optic atrophy appeared in 40 cases, and in numerous cases perforation of the globe resulted from panophthalmitis. In 68 cases of ophthalmic zoster the patient was under 20 years of age; in 44 cases, under 13 years; in 24 cases, under 6 years, and in 14 cases under 1 year of age.

REPORT OF PERSONAL CASES

J. C., a man aged 75, complained of severe pain over the right eye and the right side of the head one day after being exposed to a cold wind and rain. The neuralgic pain was of sudden onset in the area of distribution of the first branch of the fifth nerve, followed in two days by a vesicular eruption.

He was seen two days after the eruption, which appeared on the right side of the forehead, sharply demarcated against the midline and extending to the scalp, eyebrow and external palpebral commissure. There was associated edema of the conjunctiva, which partly covered the cornea, with increased lacrimation. Vision at this time was 20/100 in the right eye and 20/20 in the left eye. The temperature was 37.5 C. (99.5 F.), the respiratory rate 20 and the pulse rate 90 a minute. The white cell count was 10,000. The urine was normal, and the Wassermann reactions of the blood and the spinal fluid were negative. The personal history was noncontributory. The patient was a well developed, well nourished, healthy man. The heart was normal in size, rate and rhythm. No murmurs were present. The blood pressure was 160 systolic and 80 diastolic. The lungs were clear on percussion and auscultation, and no rales were present. The abdomen showed no tenderness or palpable masses. The reflexes were normal.

Four days later sudden diplopia appeared, due to paralysis of the right sixth nerve. There were simultaneous increase in the periorbital edema and the appearance of a new crop of vesicles at the nasal angle of the right eye and over the right half of the nose, in the area supplied by the infratrochlear nerve. The eyeball became intensely injected, with much lacrimation and mucopurulent discharge. The ocular tension was increased. A few erosions were noted on the cornea, which was somewhat edematous and hazy. The corneal infiltrate involved most of the nasal half of the cornea, with some vascularization. Hyperesthesia of the skin was present in the area supplied by the fifth nerve. The cornea was insensitive.

The paralysis of the abducens nerve coincided with the appearance of the secondary crop of vesicles at the nasal angle of the right eye, probably the result of the direct extension from the nasociliary nerve to the sixth nerve in their passage through the supraorbital foramen or deeper in the orbit.

The cutaneous eruption went through the stages of vesicle formation, drying of pustules, crusting and pigmented scarring. The acute phase of the infection subsided in about eight weeks, and sixteen weeks later all symptoms had disappeared. The resulting vision was 20/60. All diplopia disappeared in two weeks, and the tension returned to normal.

The pupil was kept dilated with 1 per cent atropine sulfate, and 10 per cent neo-silvol was used in the eye three times daily. The eye was kept covered. Salicylates were administered freely for the relief of pain. Calamine lotion was used for the lesions of the skin. Thiamine hydrochloride, 2,000 units, was given daily for six days.

CASE 2.—E. R., a man aged 40, after a few days of general malaise, headache and pain in the left supraorbital region, presented typical herpes zoster of the first branch of the left trigeminal nerve. When he was first seen, there was an eruption of vesicles, some dried and crusted, on the left upper lid and the left side of the forehead and nose, sharply limited to the midline. The lid was edematous and heavy, with chemosis of the bulbar conjunctiva. There was no proptosis or immobility of the globe. The cornea was hazy, with small areas of ulceration and a definite ciliary flush. The pupil was moderately dilated. The ocular tension was normal. No details of the fundus could be seen.

The temperature was 37.5 C. (99.5 F.); the white blood cell count was 9,500; the urine was normal, and the Wassermann reactions of the blood and spinal fluid were negative.

His sight had always been good in each eye, and there was no history of any previous ocular trouble. His general health was excellent. Examination of the heart and lungs did not reveal any abnormality or evidence of disease. The abdomen showed no areas of tenderness.

Atropine was used to dilate the pupil, and local supportive measures were administered. Autohemotherapy, with injection of 10 cc., was used and the injection repeated two days later. Immediate cessation of pain followed, and definite improvement was noted in the cutaneous eruption.

Three weeks later the corneal involvement had disappeared, with no remaining leukoma. Vision was normal in each eye. The pupil was round and reacted normally to light, in accommodation and consensually.

The fundus showed no abnormality. There was no subjective or objective evidence of disturbed equilibrium of the ocular muscles. Vision was 20/30.

CASE 3.—C. G., a man aged 45, complained of severe pain and inflammation of the left eye. Neuralgia persisted, and soon there was swelling over the left temporal region; the lids became swollen and closed. The next day many small, yellow, raised and irregular blisters appeared on the left side of the nose, the upper and lower lids of the left eye and the skin of the left frontal region as far as the hair line. These vesicles were absent from the remainder of the face and were definitely delimited by the median line, so that they occupied the left side of affected regions exclusively. The conjunctiva was decidedly hyperemic and chemotic. The cornea showed several small, pinhead erosions. The pupil was dilated, and the iris was free. ocular tension was not increased. The preauricular and posterior cervical glands were enlarged.

The temperature was 37 C. (98.6 F.); the pulse rate was 78 a minute. The white cell count was 11,950, and the red cells were increased to 5,720,000. The urine showed an excess of albumin. The Wassermann reaction was negative. The results of the general physical examination were essentially normal. His health had always been good, and there was no history of any previous trouble with the eyes.

On the sixteenth day diplopia developed, due to paralysis of the left sixth nerve, which in two weeks had disappeared. At the end of the third week the corneal disturbances had also disappeared, with regeneration of corneal epithelium. Some superficial vessels were noted at the nasal limbus of the cornea. Vision was 20/40.

At this time the vesicles of the skin had dried and formed thick, yellow-brown crusts, which fell off, leaving deep pits in the skin. Complete anesthesia persisted and extended to the scalp.

In this case the first and second branches of the left fifth nerve were affected. No specific treatment was administered. Atropine was used in the left eye as soon as the corneal condition was noted. Neosilvol, 10 per cent, was instilled in the eye three times a day, and the eye was kept closed. Calamine lotion was used on the surface of the skin. Acetylsalicylic acid was given freely for the relief of pain.

CASE 4.—P. F., a man aged 62, complained of severe pain over the right eye, which extended up and back over the frontal and the parietal region. This pain lasted for forty-eight hours and was much increased during each night. The right upper lid was swollen and heavy, causing the eye to close. By lifting the lid, however, he could see that his vision was not affected. The pain he described as an "intermittent lightning pain," from which he was not free at any time. The neuralgia later extended down the right side of his nose. At this time, on the fifth day, vesicles appeared over the painful region, to the right of the midline. The pain lessened but did not disappear. The vesicles were clear, extending over the frontal region into the scalp and along the right side of the nose to the tip. On the right brow was a large, linear vesicle. Two vesicles appeared on the upper right lid. The eye was intensely engorged, with much lacrimation and photophobia. Some conjunctival discharge was present. Several small vesicles appeared on the cornea, and vision was greatly reduced. These vesicles occupied most of the pupillary area of the anesthetic cornea. Part of the iris could be seen and appeared swollen. The pupil was indistinct but of medium size and was not quite round. No details of the fundus could be seen. The preauricular glands were enlarged. The heart and lungs showed no evidence of disease. The blood pressure was 140 systolic and 75 diastolic. The abdomen showed no areas of tenderness.

Atropine was used as soon as the cornea was involved. Part of the iris remained fixed and swollen, and the vessels of the iris were easily seen. Tension remained normal. Autohemotherapy, with injection of 10 cc., was used and the injection repeated twice, on alternate days. Calamine lotion was used on the cutaneous lesions. On the fifth day all pain had vanished, and the cutaneous eruption was vastly improved. The crusts of the skin loosened, leaving deep scars corresponding to the confluent group of vesicles.

Examination with the slit lamp showed small opacities in the deeper corneal layers, with deposits on Descemet's membrane. After staining with fluorescein, the minute corneal defects could be seen to greater advantage. The iris showed atrophy and appeared a duller tint than the iris of the other eye. It had lost its areolar structure; some crypts were effaced, and the fibrils were blurred. A few pigmentary spots were noted on the anterior capsule.

The white cell count was 8,100, and the red cell count was 4,850,000. The urine was normal, and the Wassermann reactions were negative.

Six weeks later the ocular condition was quiet, with a central corneal leukoma remaining. At this time he suffered severe pain in the right eye, and two days later there appeared some ciliary injection and a hazy area was noted below the cornea. A small nodule of violet-slate color developed, with marked injection of vessels at this point; this nodule became a small vesicle on one of the anterior ciliary nerves, resembling an area of episcleritis. Atropine sulfate, 1 per cent, was again used in the eye, and the pupil was kept in a state of dilatation. The eye was kept covered. Sodium salicylate, 10 cc., was given three times a day until all pain and discomfort disappeared. Weeks later the conjunctiva recovered its normal condition, and the nodule was less pronounced, appearing of a grayish tint. Four weeks later the nodule had disappeared, and in its place was a small darkened discoloration of the sclera. This nodule was beneath the conjunctiva and near the limbus but did not touch the cornea. One year later vision was 20/30 with correction.

CASE 5.—Mrs. T. T., aged 70, was first seen five days after the outbreak of herpes zoster. A number of vesicles were noted on the left upper lid and the forehead, scalp and tip of the nose on the left side. There was intense ocular congestion with a central corneal ulcer. Severe neuralgic pain was present over the area involved, and from the upper left lid to the scalp the skin was red and tender, with swelling of the preauricular glands.

Vision was greatly reduced. The temperature was 38 C. (100.4 F.). The urine was normal, and the Wassermann reactions of the blood and spinal fluid were negative. The red cell count was 3,750,000 and the white cell count 10,000. The differential count showed 41 per cent polymorphonuclears, 30 per cent eosinophils, 22 per cent small lymphocytes, 5 per cent large lymphocytes and 1 per cent basophils. The hemoglobin concentration was 84 per cent. The general physical examination did not contribute anything pertinent to the case. There was a history of exposure to chickenpox, three weeks before her present illness.

Ten cubic centimeters of blood was withdrawn from the arms and injected into the gluteal region (auto-

hemotherapy). This was repeated two days later. After four days there was complete cessation of the pain, and the cutaneous condition was much improved and the eruption had mostly disappeared. This treatment, however, did not seem to have any effect on the corneal condition. Atropine was used to keep the pupil dilated. Codeine was used for relief of the pain, and calamine lotion was used over the skin of the forehead and the scalp.

About four weeks after the onset the edema of the lid had subsided, and the patient was able to keep her eye open. The eyeball was considerably injected throughout the illness, with much lacrimation and mucopurulent discharge. The corneal ulcer had healed, but corneal sensation was still greatly diminished. At this time there were noted many minute, gray papules in the cornea, and she complained of diplopia. Examination showed this to be due to paresis of the left trochlear nerve.

The pupil was round and measured 6 mm. in diameter. The fundus details were hazy. Examination with the slit lamp revealed numberless minute gray spots situated in the epithelial layer of the cornea, in contact with Bowman's membrane. These spots were more dense toward the center and more scattered at the periphery. The superficial outline of the iris could be easily seen. The pupillary margin was pigmented, and in places particles of pigment had become separated from the iris. Two small holes were seen in the iris, which permitted light to pass through.

For several months severe neuralgia remained in the left eye, left temple and scalp. Cutaneous anesthesia was present. The upper lid remained red and thickened, and the eyeball was injected for some time. The conjunctival injection gradually subsided, and the skin of the upper lid and forehead was extremely tender to touch for a long time. The corneal involvement gradually became less apparent. The diplopia gradually became lessened and in one year had disappeared. Vision was 20/30.

BIBLIOGRAPHY

Abadie, J.: Douleurs névralgiques anciennes consécutif au zona guéris immédiatement par la ponction lombaire, Gaz. hebd. d. sc. méd. de Bordeaux **23**: 628, 1902; Bull. Soc. franç. de dermat. et syph., April 10, 1898; cited by Griffith.

Achard, C.: Zona ophtalmique, Paris méd. **1**:285, 1924.

——and Castaigne, J.: Zona céphalique, Gaz. hebd. de méd. **2**:1177, 1897.

Achtermann, W.: Ueber Herpes corneae, Inaug. Dissert., Marburg, J. A. Koch, 1876.

Adams, cited by Moore.

Adler: 2 Fälle von Herpes zoster ophthalmicus, Jahresb. u. d. Leistung. u. Fortschr. im Geb. d. Ophth. **7**:447, 1876.

Adrogué, E.: Queratitis herpética, Rev. Asoc. méd. argent. (Soc. de oftal.) **37**:51, 1924.

Agnello, F.: Varietà cliniche e lesioni oculari nello zoster oftalmicus, Riv. oto-neuro-oftal. **11**:172, 1934.

Ahlström, G.: Några komplikationer vid herpes zoster ophthalmicus, Hygiea **4**:920, 1904.

Aitken, R. S., and Brain, R. T.: Facial Palsy and Infection with Zoster Virus, Lancet **1**:19, 1933.

Aliquo-Mazzei, A.: Ocular Complications in Herpes Zoster Ophthalmicus, Atti Soc. ital. d'oftal., 1938, p. 149.

Allbutt, T. C., and Rolleston, H. D.: System of Medicine, London, Macmillan & Co., 1910, vol. 7, p. 475.

Altmeyer, J.: Bestehen Beziehungen zwischen Blutkörperchensenkungsgeschwindigkeit, Leukocytenzahl und therapeutischer Ansprechbarkeit bei der Behandlung der Gonorrhöe mit Sulfonamiden? Mitteilung eines Falles von Zoster symptomaticus nach Diseptal-C, Arch. f. Dermat. u. Syph. **179**:279, 1939.

de Amicis, T.: Caso rarissimo di zoster bilaterale universale, Gior. internaz. d. sc. med. **4**:75, 1882.

Amies, C. R.: Elementary Bodies of Zoster and Their Serological Relationship to Those of Varicella, Brit. J. Exper. Path. **15**:314, 1934.

Ammann, E.: Herpes zoster ophthalmicus traumaticus, Klin. Monatsbl. f. Augenh. **95**:793, 1935.

Anderson, J. S.: Bilateral Herpes Zoster, Brit. M. J. **2**:592, 1931.

Andjelkovitch: Zona ophtalmique avec complication d'iritis, Thesis, Lyon, 1924.

Andre: Herpes zoster frontalis seu ophtalmique, Presse méd. **24**:17, 1872.

André-Thomas and Heuyer: Dégénération de la racine descendante du trijumeau et hemorragies bulbo-protubérantielles dans un cas de zona ophtalmique, Rev. neurol. **20**:776, 1912.

Un cas de zona ophtalmique suivi d'autopsie, ibid. **20**:381, 1912.

——and Laminiàre: Les lésions medullaires du zona, ibid. **15**:693, 1907.

Anger, B.: Zona ophtalmique avec conjonctivite, hyperesthésie consécutive, Gaz. d. hôp. **46**:930, 1873.

Antonelli, A.: Zona ophtalmique et névrite optique, J. de méd. de Paris **15**:61, 1903.

Ardouin, P.: Trois observations de zona ophtalmique, Arch. méd.-chir. de Province **23**:178, 1933.

Arent de Besche: Herpes zoster mit pathologisch-anatomischen Veränderungen im Rückenmark, Centralbl. f. allg. Path. u. path. Anat. **21**:897, 1910.

von Arlt, F. R.: Neue Therapie bei Herpes zoster frontalis, Wchnschr. f. Therap. u. Hyg. d. Auges **12**:137, 1909.

von Arlt, R.: Herpes zoster trigemini, Anz. d. k. k. Gesellsch. d. Aerzte in Wien, 1871, p. 141; Wien. med. Presse **12**:1216, 1871.

Armaignac, H.: Zona ophtalmique grave avec complication de kératite et d'iritis, Rev. clin. d'ocul. **4**:273, 1884.

Arnold, cited by Königstein.

Arnstein, A.: Herpes zoster und innere Erkrankungen, Wien. Arch. f. inn. Med. **4**:441, 1922.

Atkinson, D. T.: External Diseases of the Eye, Philadelphia, Lea & Febiger, 1934, p. 81.

Aubaret, E., and Margaillan: Zona ophtalmique avec blépharospasme et myosis, Marseille-méd. **60**:805, 1923.

——and Mastier: Zonas ophtalmiques et troubles de la tension oculaire, Rev.d'oto-neuro-ocul. **3**:386, 1925.

——and Morenon: Zona ophtalmique associé à un syndrome de Claude Bernard-Horner avec érythrodermie, Rev. neurol. **34**:201, 1927.

——and Ourgaud, G.: Zone ophtalmique et glaucome, Marseille-méd. **59**:342, 1922.

Aubineau, E.: Zona ophtalmique avec ophtalmoplégie, Gaz. méd. de Nantes **32**:181, 1914; Clin. opht. **7**: 513, 1914-1915.

Aurand: Mydriase consécutive à un zona ophtalmique, Lyon méd. **129**:458, 1920; cited by Genet (1925).

Avalos, E.: Algunas aplicaciones de la auto-hemoterapie en terapéutica ocular, An. Soc.méx. de oftal. y oto-rino-laring. **7**:208, 1929.

Badeaux, F.: Radiothérapie zu zona ophtalmique et de l'herpès cornéen, J. de l'Hôtel-Dieu de Montréal **4**:138, 1935.

Radiotherapy in Herpes Zóster Ophthalmicus and Herpetic Keratitis, Tr. Sect. Ophth., A. M. A., 1935, p. 60.

Badot, J.: Douleurs neuralgiques au zona ophtalmique, Bull. Soc. belge d'opht., 1931, no. 62, p. 9.

Bär, A.: Ein Folgezustand von Herpes zoster ophthalmicus, Ztschr. f. Augenh. **55**:393, 1925.

von Bärensprung, F. G. F.: Die Gürtelkrankheit, Ann. d. Char. Krankenh. **9**:40, 1861.

Fernere Beiträge zur Kenntniss des Zoster, ibid. **10**:37, 1862; **11**:96, 1863.

Baldenweck and Degorce: Zona otique total, associéà un zona du trijumeau, du glosso-pharyngien et du laryngé supérieur, Rev. d'oto-neuro-opht. **17**:29, 1939.

Baliña, P. L., and Herrera, J. A.: Herpes Zoster Ophthalmicus with Total Paralysis of Third Nerve, Rev. argent. dermatosif. **19**:178, 1935.

Ballarini, M.: Ricerche cliniche sulla topografia dell'herpes zoster, Arch. ital. di dermat., sif. **12**:3, 1936.

Bane, W. C.: Herpes Zoster Ophthalmicus with Report of Five Cases, Ophth. Rec. **10**:431, 1901.

Herpes Zoster Ophthalmicus, ibid. **25**:98, 1916.

——and Bane, W. M.: Keratitis Profunda and Glaucoma Accompanying Herpes Zoster Ophthalmicus, Am. J. Ophth. **16**:816, 1933.

Baranov, M.: Herpes Zoster Ophthalmicus with Internal Ophthalmoplegia, Tr. Ophth. Soc. U. Kingdom **42**:167, 1922.

Barber, H. W.: Case of Herpes Zoster Involving Simultaneously the Thorax and Ophthalmic Division of Fifth Nerve, Lancet **2**:1136, 1919.

Barker, L. P.: Generalized Herpes Zoster, Arch. Dermat. & Syph. **40**:974 (Dec.) 1939.

Barksdale, E. E.: Autohemotherapy in Treatment of Herpes Zoster, Virginia M. Monthly **64**:378, 1937.

Barling, B., and Cahill, J.: Herpes Zoster Ophthalmicus Coincident with Varicella in Adults, Brit. M. J. **1**: 823, 1930.

Barrada, M. A.: Case of Herpes Zoster Ophthalmicus, Bull. Ophth. Soc. Egypt **27**:107, 1934.

Barraux, Assale and Bastouil: Zona oftálmico traumático, Rev. oto-neuro-oftal. **10**:315, 1935.

Barré, J. A.: Blépharospasme et zona du rameau nasal de l'ophtalmique, Rev. d'oto-neuro-ocul. **2**:132, 1924.

Barrett, J. W., and Orr, W. F.: Diplopia Following Herpes Zoster Ophthalmicus, Intercolon. M. J. Australasia **7**:330, 1902.

Barrio de Medina: Autohämotherapie in der Dermatologie, Zentralbl. f. Haut- u. Geschlechtskr. **22**:199, 1927.

Barth, H.: Pathogénique et physiologie pathologique de l'herpes zoster, Ann. de dermat. et syph. **3**:173 and 232, 1882.

Bateman, cited by Evans.

Batignani, A.: Ophthalmoplegia da zoster, Boll.d'ocul. **13**:814, 1934.

Bayer, H.: Ueber Herpes zoster ophthalmicus und Unfall, Inaug. Dissert., Freiburg i. Br., Speyer & Kaerner, 1906.

Bayliss, W. M.: The Reaction of Blood Vessels in Alterations of Internal Pressure, J. Physiol. **26**: xxix, 1901.

Beam, A. D., and Lindberg, V. L.: Case of Herpes Zoster Ophthalmicus, J. Michigan M. Soc. **38**:301, 1939.

Beauvois, cited by Wood, C. A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1916, vol. 8, p. 5892.

Becker, S. W., and Obermayer, M. E.: Modern Dermatology and Syphilology, Philadelphia, J. B. Lippincott Company, 1940.

Bedson, S. P., and Bland, J. O. W.: On Supposed Relationship Between Viruses of Herpes Febrilis and Vaccinia, Brit. J. Exper. Path. **9**:174, 1928.

Complement-Fixation with Filterable Viruses and Their Antisera, ibid. **10**:393, 1929.

Beeson, B. B.: Autohemotherapy in Treatment of Herpes Zoster, Arch. Dermat. & Syph. **18**:573 (Oct.) 1928.

Herpes Zoster: Some Remarks About Its Treatment, Illinois M. J. **57**:174, 1930.

Bénard, R., and Joltrain, E.: Traitement du zona et des herpès par les injections intraveineuses d'eau sulfureuse, Bull. et mém. Soc. méd. d. hôp. de Paris **51**:1013, 1927.

Berggreen, P., and Schüler, E. G.: Zur Kenntnis der Lokalisation des Herpes zoster, Dermat. Wchnschr. **106**:216, 1938; abstracted, Am. J. Syph., Gonor. & Ven. Dis. **22**:536, 1938.

Berlin, cited by Ginsberg.

Berrisford, P. D.: Herpes Zoster Ophthalmicus, Minnesota Med. **18**:741, 1935.

Besnier, cited by Wood, C. A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1916, vol. 8, p. 5886.

Bézi, S.: Gesichtszoster im Gebiet des I und II Trigeminusastes, Verhandl. d. deutsch. path. Gesellsch. **24**:318, 1929.

Billimoria, N. P.: Treatment of Herpes Zoster Ophthalmicus, Proc. All-India Ophth. Soc. **6**:156, 1938.

Biozzi, G.: Sulle manifestazioni oculari nella sindrome del ganglio sfeno-palatino, Riv. oto-neuro-oftal. **12**: 730, 1935.

Blachez: Zona ophtalmique, Gaz. d. hôp. **53**:179, 1880; J. de méd. et chir. prat. **51**:9, 1880.

Blaschko, cited by Hoennicke, E.: Die Häufigkeit des Herpes zoster, Berl. klin. Wchnschr. **38**:786, 1901.

von Bókay, J.: Gürtelrose und Windpocken, Jahrb. f. Kinderh. **119**:127, 1928.

Ueber die Identität der Aetiologie der Schafblattern und einzelner Fälle von Herpes zoster, ibid. **89**:380, 1919.

Bonar, B. E., and Pearsall, C. J.: Herpes Zoster in the Newborn, Am. J. Dis. Child. **44**:398 (Aug.) 1932.

Boner, L.: Contribution à l'étude du zona syphilitique, Thesis, Paris, no. 83, 1917.

Bonnet, P.: La topographie en secteur, des lésions de la cornée, dans le zona ophtalmique, Bull. Soc. d'opht. de Paris **51**:434, 1939.

——and Colrat, A.: Kératite interstitielle nodulaire tardive dans le zona ophtalmique, ibid., 1933, p. 700.

Boulloche, P.: Un cas de zona ophtalmique, Méd. mod. **8**:297, 1897.

Bowman, W.: Case of Zoster, or Unilateral Confluent Herpes of Ophthalmic Region, M. Times & Gaz., 1867, p. 432; Ophth. Hosp. Rep. **6**:1, 1867-1869.

Bradburne, A. A.: Herpes Zoster Frontalis Associated with Glaucoma, Ophth. Rec. **18**:169, 1909; Lancet **2**:1598, 1908.

Bradshaw, T. R.: Herpes Zoster Affecting Frontal and Dorsal Regions Simultaneously, Lancet **2**:851, 1894.

Brain, R. T.: Demonstration of Herpetic Antibody in Human Sera by Complement-Fixation: Correlation Between Its Presence and Infection with Herpes Virus, Brit. J. Exper. Path. **13**:166, 1932.

Relationship Between Viruses of Zoster and Varicella as Demonstrated by Complement-Fixation Reaction, ibid. **14**:67, 1933.

Brain, W. R.: Zoster, Varicella and Encephalitis, Brit. M. J. **1**:81, 1931.

Braun, S.: Contribution à l'étude des complications oculomotrices du zona ophtalmique, Paris, 1930.

Brav, A.: Herpes Zoster Ophthalmicus Complicated with Acute Glaucoma, with Report of a Case Treated for Erysipelas, Am. J. Dermat. & Genito-Urin. Dis. **15**:365, 1911.

Brissaud: Du zona ophtalmique avec hémiplégie croisée, J. de méd. et chir. prat. **67**:209, 1896; Gazz. de osp. **17**:477, 1896.

In Wilbrand, H., and Saenger, A.: Neurologie des Auges, Munich, J. F. Bergmann, 1921, vol. 8, p. 238.

Broadbent, W. H.: Partial Herpes Frontalis with Inflammation of the Eye, Brit. M. J. **2**:749, 1876.

Brooks, W. D. W.: Zoster, Hiccup and Varicella, Brit. M. J. **2**:298, 1931.

Brown, W. H., and Dujardin, B.: The Cerebrospinal Fluid in Herpes Zoster and the Relation of Herpes Zoster to Syphilis, Brain **42**:86, 1919.

Browne, F. E.: Action of Herpes Zoster Virus and Its More Unusual Manifestations, M. J. Australia **2**: 621, 1931.

Bruce, A. N.: An Explanation of the Eruption in Herpes Zoster, Rev. Neurol. & Psychiat. **10**:471, 1912.

Bruusgaard, E.: Mutual Relation Between Zoster and Varicella, Brit. J. Dermat. **44**:1, 1932.

Bryan, W. M. C.: Control of Pain of Herpes Zoster of the Nervus Ophthalmicus Through Nasal Ganglion and Through Sphenoid Sinus, Laryngoscope **33**: 703, 1923.

Buckley, cited by Wheelock.

Buhnemann, H. J.: Involvement of Conjunctival Bulbi in Herpes Zoster Ophthalmicus, Inaug. Dissert., Würzburg, 1937.

Bulkley: Case of Herpes Zoster Frontalis Successfully Treated by Electricity, Arch. Dermat. **1**:54, 1874.

Buller, F.: Case of Zoster-Ophthalmicus, Montreal M. J. **21**:100, 1892-1893.

Burgess, N.: Bilateral Herpes Zoster, Brit. M. J. **2**:384, 1931.

Burwell, E. B.: Unusual Case of Herpes Zoster Ophthalmicus, Eye, Ear, Nose & Throat Monthly **1**:361, 1922.

Busfield, J.: Herpes and Varicella, Brit. M. J. **2**:1124, 1913.

Bussy and Bonamour: Zona ophtalmique à début oculaire, Bull. Soc. d'opht. de Paris, 1936, p. 380.

Cabannes: Sur un cas de zona ophtalmique avec névrite optique, Gaz. hebd. de sc. méd. de Bordeaux **24**:184, 1903.

Calhoun, A. W.: Herpes Zoster Ophthalmicus, Atlanta M. & S. J. **11**:188, 1873.

von Cammerloher: Herpes zoster ophthalmicus gangraenosus im Gebiet des Nerv. supraorbitalis und Ramus frontalis, Ztschr. f. ärtzl. Fortbild. **14**:578, 1917.

Campbell, R. M.: Bilateral Herpes Zoster of Trigeminal Nerve, Lancet **1**:1066, 1936.

Camus, F. A.: Contribution à l'étude de zona de la face, Thesis, Paris, no. 338, 1880.

Cantonnet, A.: Le zona ophtalmique, Clinique, Paris **30**:3, 1935.

Carlevaro, G. F.: Azione della vitamina B_1 in alcune affezioni oculari, Ann. di ottal. e clin. ocul. **67**:355, 1939.

Carmody, R. F.: Herpes Zoster Ophthalmicus Complicated by Ophthalmoplegia and Exophthalmos, Arch. Ophth. **18**:707 (Nov.) 1937.

Carnot, P.; d'Hauthuile, G., and Fiessinger, H.: Un traitement du zona par le sang d'anciens zonateux, Paris méd. **2**:534, 1940.

Carpenter, in Wilbrand, H., and Saenger, A.: Neurologie des Auges, Munich, J. F. Bergmann, 1921, vol. 8, p. 239.

Carré, A.: Note sur un cas de zona ophtalmique, Mém. et compt.-rend. Soc. d. sc. méd. de Lyon (1874) **14**:42, 1875; Lyon méd. **16**:262, 1874.

Du zona ophtalmique, Union méd. **27**:153, 1879.

Carter, H. R.: Case of Herpes Zoster Following Lumbar Puncture, Am. J. Psychiat. **94**:373, 1937.

Caspar, L.: Herpes zoster ophthalmicus und Trochlearis-Lähmung, Arch. f. Augenh. **48**:177, 1903.

Herpes palpebralis, Wchnschr. f. Therap. u. Hyg. d. Auges **10**:141, 1906-1907.

Herpes Zoster Ophthalmicus and Paralysis of Trochlearis, Arch. Ophth. **27**:588, 1908.

Chambers, G.: Case of Herpes Zoster Ophthalmicus, Dominion M. Monthly **20**:86, 1903.

Chance, B.: Herpes Zoster Ophthalmicus with Involvement of Cornea and with Oculomotor Paresis, Ann. Ophth. **18**:221, 1909.

Herpes Zoster Ophthalmicus, ibid. **24**:693, 1915.

Herpes Zoster Ophthalmicus, Ophth. Rec. **26**:47, 1917.

Chandelux, A.: Observation pour servir a l'histoire des lésions nerveuses dans le zona, Arch. de physiol. norm. et path. **6**:674, 1879.

Charcot, J. M.: Lectures on the Diseases of the Nervous System, translated by G. Sigerson, London, New Sydenham Society, 1877, vol. 1, p. 76; cited by Metz (1913).

Chauffard, A., and Rendu, H.: Méningite zonateuse tardive dans un cas de zona ophtalmique, Bull. et mém. Soc. méd. d. hôp. de Paris **24**:141, 1907; Rev. gén. d'opht. **26**:139, 1907.

Chemolosoff, A. S.: Herpes Zoster Ophthalmicus Seu, Med. pribav. k. mosk. sborniku, 1898, p. 198.

Ciotola, G.: Sintoma di Argyll-Robertson unilaterale consecutivo a zona oftalmico, Boll. d'ocul. **15**:1294, 1936.

Clark, C. F., in discussion on Veasey.

Clarke, E. A.: A Case of Herpes Zoster Ophthalmicus, Ophth. Rec. **19**:174, 1910.

Claude, H., and Schaeffer, H.: Paralytischer Zoster der Hirnnerven und die Theorie der Poliomyelitis posterior acuta, Arch. f. Dermat. u. Syph. **112**:98, 1912.

Clavelier: Heilung einer im Verlauf eines Herpes zoster ophthalmicus auftretenden Episcleritis durch Electrolyse, Ophth. Klin. **2**:274, 1898.

Cofler, A.: Contribuzione alla casuistica dell'herpes zoster ottalmico, Ann. di ottal. **4**:391, 1875; Gazz. med. ital., prov. venete **18**:137, 1875.

Cohn and Jacksch, cited by Désirat.

Cohn, R. D.: Ueber den Herpes zoster ophthalmicus, Arch. f. Augenh. **39**:148, 1899.

Cole, R., and Kuttner, A. G.: Etiology of Herpes Zoster, J. Exper. Med. **42**:799, 1925.

Colley, cited by Königstein.

Collier, J., in Price, F. W.: Practice of Medicine, New York, Oxford University Press, 1926.

Collins, W. J.: Case of Paralysis of Sensory Branches of Right Fifth Nerve, With Cataract and Without Any Corneal Change, Tr. Ophth. Soc. U. Kingdom **8**:254, 1888.

Paralysis of Fifth Nerve Associated with Cataract, Brit. M. J. **1**:1338, 1888.

Colrat, A.: Zona ophtalmique et glaucoma, J. de méd. de Lyon **12**:181, 1931; cited by Voisin.

Cookson, H. A.: Herpes Zoster an Infectious Disease, abstracted, J. A. M. A. **82**:1897 (June 7) 1924.

Coppez, J.: Du zona ophtalmique et des altérations oculaires qui en dépendent, Ann. d'ocul. **69**:197, 1873; **75**:33, 1876.

Coppez, L.: Diathermy in Herpes Zoster, Bull. Soc. belge d'opht., 1929, no. 58, p. 56.

Corlett, cited by Ormsby.

Cornil, L., and Blanc, F.: Contribution à l'étude de l'infection varicello-zostérienne, Rev. neurol. **2**:123, 1931.

Corson, E. F., and Knowles, F. C.: Unusual Case of Herpes Zoster Including Simultaneous Unilateral Supra-Orbital and Thoracic Eruption, Arch. Dermat. & Syph. **5**:619 (May) 1922.

Coursserant: Zona ophtalmique traumatique, Bull. Soc. méd.-prat. de Paris, 1877, p. 134.

Cousin, G., and Périsson, J.: Un nouveau cas de signe d'Argyll unilatéral consécutif à un zona ophtalmique, Rev. neurol. **36**:150, 1929.

Couyba, L.: Herpès frontal et angine; mort, J. de méd. et chir. prat. **48**:547, 1877.

Cowie, D. M.: Herpes Zoster Hemorrhagica (Trigeminal), Physician & Surg. **26**:491, 1904.

Crisp, W. H., in discussion on Lucic.

Crocker, H. R.: Diseases of Skin, ed. 3, Philadelphia, P. Blakiston's Son & Co., 1903, p. 234.

Cross, A. E.: Herpes Zoster Ophthalmicus: Report of a Case Treated by Pericorneal Neurotomy, J. Am. Inst. Homeopathy **10**:1545, 1918.

Cuénod and Nataf, R.: Adénite zostérienne primitive prééruptive dans un cas de zona ophtalmique, Bull. et mém. Soc. franç. d'opht. **46**:201, 1933.

Curschmann, cited by Zeeman.

Curschmann, H., and Eisenlohr, C.: Zur Pathologie und pathologischen Anatomie der Neuritis und des Herpes zoster, Deutsches Arch. f. klin. Med. **34**: 409, 1883-1884.

Cushing, H.: The Sensory Distribution of the Fifth Cranial Nerve, Bull. Johns Hopkins Hosp. **15**:213, 1904.

Major Trigeminal Neuralgias and Their Surgical Treatment Based on Experiences with 332 Gasserian Operations, Am. J. M. Sc. **160**:157, 1920.

Czermak, W.: Erwiderung auf Dr. Berger's Bemerkung "Zur Zonulafrage," Arch. f. Ophth. **31** (pt. 4):295, 1885.

Dabney, S. G.: Herpes Zoster Ophthalmicus in Negro, Kentucky M. J. **28**:213, 1931.

DaFonseca, L.: Zona ophthalmica do lado direito; keratite neuroparalytica; hypopio; irite plastica, Arch. ophth. de Lisboa **3**:34, 1882; Rev. de cien. méd. **8**:458, 1882.

Daguenet: Du zona ophthalmique, avec névrite optique du côté correspondant, Rec. d'opht. **4**:117, 1877; cited by Jessop.

Dainow, I.: Note préliminaire sur le traitement de l'herpès et du zona par la vitamine C, Ann. de dermat. et syph. **7**:817, 1936.

Dalbey, J. W., and Dean, L. W.: Report of Two Cases of Herpes Zoster Ophthalmicus, Ophth. Rec. **8**: 572, 1899.

Dalsgaard-Nielsen, E.: Case of Basal Radicular Meningitis Following Herpes Zoster Ophthalmicus, Dansk med. Selsk. Forhandl., 1934-1935, p. 56.

Danielson, R., in discussion on Walker, C. J.

Danlos: Zona ophthalmique ayant simulé pendant quelques jours un érysipele léger, Ann. de dermat. et syph. **7**:366, 1896; Bull. Soc. franç. de dermat. et syph. **7**:184, 1896.

Darier, A.: Traité complet de thérapeutique oculaire, Paris, Jouve & Cie, 1921, p. 441.

Darier, J.: Précis de dermatologie, Paris, Masson & Cie, 1923, p. 171.

Davenport, R. C., cited by Savin, p. 280.

Davidson, A.: The Etiology of Herpes Zoster, Urol. & Cutan. Rev. **29**:658, 1925.

Davies, cited by Königstein.

Debore: Le zona ophtalmique, Rev. gén. de clin. et de thérap. **22**:353, 1908.

Decbaume, cited by Voisin.

Decker, C.: Zur Aetiologie des Herpes corneae, Klin. Monatsbl. f. Augenh. **28**:105, 1890.

Dennis, F. L.: Herpes Zoster Oticus: Involvement of Fifth, Seventh, Eighth and Ninth Cranial Nerves and Complete Vestibular Examination, Laryngoscope **35**:665, 1925.

De River, J. P.: Bilateral Abducens Paralysis Associated with Paralysis of Convergence, M. J. & Rec. **124**:553, 1926.

de Schweinitz, G. E., in discussion on Veasey.

Deshayes, C.: Observation de zona de la cinquième paire, Assoc. franç. p. l'avance. d. sc., Compt. rend. (1883) **12**:709, 1884.

Désirat, A. J.: Contribution à l'étude de quelques complications rares du zona ophtalmique, névrite optique, ophtalmoplégies, paralysies éloignées, Thesis, Bordeaux, no. 126, 1903, p. 179.

Desobry: Zona ophthalmique en enfant, Medical Department, University of Lyon, 1921.

Deutschmann, F.: Herpes zoster und Optikuserkrankung, Klin. Monatsbl. f. Augenh. **73**:776, 1924.

Disson, cited by Elliot.

Doerr, R.: Ergebnisse der neueren experimentellen Forschungen über die Aetiologie des Herpes simplex und des Zoster, Zentralbl. f. d. ges. Ophth. **14**: 705 and 833, 1924-1925; **15**:1, 313 and 537, 1925-1926; Zentralbl. f. Haut- u. Geschlechtskr. **13**:417, 1924.

Doggart, J. H.: Herpes Zoster Ophthalmicus, Brit. J. Ophth. **17**:513, 1933.

Dopter, cited by Sicard.

Douglas, C. E.: Case of Bilateral Herpes Zoster of Fifth Pair, Brit. M. J. **1**:808, 1895.

Drouet, L.: Le traitement du zona ophthalmique par l'autohémothérapie, Rev. méd. de l'est **52**:303, 1924.

——and Vernier, M.: Zona ophtalmique traité par l'autohémothérapie, Bull. Soc. franç. de dermat. et syph. (Réunion dermat., Nancy) **30**:27, 1923.

Dubler, A.: Ueber Neuritis bei Herpes zoster, Virchows Arch. f. path. Anat. **6**:195, 1884.

Dubois, H. F.: Een geval van herpes zoster met glaucoom, Nederl. tijdschr. v. geneesk. **1**:333, 1912; Klin. Monatsbl. f. Augenh. **53**:601, 1912.

Düring, M., and Huber, O.: Herpes corneae febrilis bei Malaria, Klin. Monatsbl. f. Augenh. **60**:368, 1918.

Dufour, in discussion on Souques, A., and Vincent, C.: Zona de la première racine Lombaire, Rev. neurol. **14**:385, 1906.

Dujardin: Zona ophtalmique, Rev. neurol. **34**:398, 1927.

Duke, W. W.: Epinephrin in Treatment of Pain of Herpes Zoster, J. A. M. A. **83**:1919 (Dec. 13) 1924.

Duméry, G.: Du zona ophtalmique et de ses manifestations graves, Thesis, Lyon, no. 43, 1896.

Duplay: Zona ophtalmique, Tribune méd. **24**:214, 1891.

Durnerin: Paralysis of Oculomotor Nerve in Ophthalmic Zona, Medical Department, University of Lyon, 1926.

Durruty, E.: L'herpès oculaire, Thesis, Paris, no. 253, 1887, p. 42.

Ebaugh, F. G., and Jefferson, R. A.: Herpes Ophthalmicus Febrilis with Dendritic Keratitis Complicating Therapeutic Malaria, Arch. Neurol. & Psychiat. **22**:1226 (Dec.) 1929.

Ebert, M. H.: Herpes Zoster, Am. J. Nursing **41**: 1125, 1941.

Ebstein, W.: Zur Lehre von den nervösen Störungen beim Herpes zoster mit besonderer Berücksichtigung der dabei auftretenden Facialislähmungen, Virchows Arch. f. path. Anat. **139**:505, 1895.

Ehara, I.: Impfrevsuche des Virus non Herpes simplex und zoster an Kaninchencornea, Igakkai Ganka Zasshi **444**:48, 1927.

Eichorst, cited by Griffith.

Eisenlohr, cited by Zeeman.

Elliot, R. H.: Observations on Herpes Zoster Ophthalmicus, Tr. Ophth. Soc. U. Kingdom **38**:351, 1918.

Emmert, E.: Drei Fälle von Herpes ophthalmicus, Wien. med. Wchnschr. **20**:984, 1870.

Erdmann, P.: Glaukomatöse Drucksteigerung bei Keratitis disciformis und herpesartige Hornhauterkrankungen, Ztschr. f. Augenh. **22**:30, 1909.

Essen-Möller, L.: Ophthalmic Zona with Unusual Complications, Nord. med. tidskr. **12**:2082, 1936.

Ettles, W.: Ionic Medication in Herpes Zoster, Lancet **1**:919, 1913.

Eulenberg, cited by Weill and Reys.

Evans, W.: Age-Incidence of Herpes Zoster, Brit. J. Dermat. **17**:199, 1905.

Eyer, A.: Zwei Fälle von Herpes zoster ophthalmicus, Ztschr. f. Augenh. **42**:234, 1919-1920.

Fabre, P.: Un cas de récidive de zona, Gaz. méd. de Paris **5**:500, 1883.

Fage: Complications rares du zona ophthalmique, Rec. d'opht. **31**:209, 1909.

Fagge and Smith, cited by Evans.

Falcão, T.: Zona ophthalmico e seu tratamento pelos raios ultravioleta, Brasil. med. **41**:1319, 1927.

Fassbender, A.: Ueber Herpes zoster ophthalmicus, nebst einem Beitrage zur Casuistik desselben, Inaug. Dissert., Strassburg i. E., C. & J. Goeller, 1896.

Federici, E.: Complicanze rare dell'herpes zoster oftalmico, Atti d. r. Accad. d. fisiocrit. in Siena (1928) **3**:727, 1929.

Erpete della cornea e sindrome di Claude Bernard-Horner, Rassegna ital. d'ottal. **6**:3, 1937.

Ferreira Marques, J.: Herpes zoster generalisatus bei Leukämie, Arch. f. Dermat. u. Syph. **176**:295, 1937.

Ferroir, J.: Zona ophthalmique, Gaz. d. hôp. **110**:230, 1937.

Fésüs, A.: Durch Stirnhöhleneiterung bedingter Herpes zoster ophthalmicus, Klin. Monatsbl. f. Augenh. **96**: 401, 1936.

Filatov, V. P.: Herpes Zoster Ophthalmicus, Vestnik oftal. **28**:941, 1911.

Fink, W. H.: Diagnosis of Herpes Zoster Ophthalmicus, Minnesota Med. **14**:322, 1931.

Fischl, F.: Herpes zoster generalisatus bei Leucaemia lymphatica, Arch. f. Dermat. u. Syph. **118**:553, 1913.

Fisher, in Rea.

Flemming, P.: Case of Ophthalmic Herpes with Hypopyon-Keratitis, Lancet **1**:587, 1899.

The Pathology of Neuropathic Keratitis, ibid. **2**:18, 1898.

Flexner, S.: Experimental Epidemic Encephalitis and Experimental Herpes, Tr. A. Am. Physicians **38**: 201, 1923.

Focosi, M.: Neurite retrobulbare acuta secondaria ad herpes zoster, Boll. d'ocul. **14**:1061, 1935.

Fordyce, P.: Bilateral Herpes Zoster, J. Cutan. Dis. **33**:319, 1915.

Forget: Du zona et de son traitement, notamment par les vésicatoires, Bull. gén. de thérap. **61**:337, 1861.

Fouassier, R.: Zona ophtalmique et vaccin antistaphylococcique, Bull. Soc. d'opht. de Paris, 1936, p. 537.

Fouchard: De la concomitance du ptosis total et du zona ophthalmique, Clin. opht., 1898, vol. 4.

Fourestier, M.: Zona maxillo-ophtalmique double, Presse méd. **47**:1055, 1939.

Fournier, A.: Un nouveau cas de guérison rapide de zona par l'iodobenzométhylformine, Arch. Soc. d. sc. méd. et biol. de Montpellier **9**:401, 1928.

Foveau de Courmelles: Les rayons X contre les névralgies et les zonas, Bull. et mém. Soc. de méd. de Paris, 1928, no. 15, p. 418.

Fox, H.: Bilateral Herpes Zoster, J. Cutan. Dis. **33**: 492, 1915.

Relief of Pain in Herpes Zoster by Paraffin, J. A. M. A. **79**:1979 (Dec. 9) 1922.

Fox, T.: A Third Attack of Herpes Zoster, Brit. M. J. **2**:139, 1870.

Franchini, Y.: Consideraciones sobre un caso de herpes zoster de epiglotis, Semana méd. **1**:1323, 1937; Rev. Asoc. méd. argent. **51**:53, 1937.

Francois, J.: Zona ophtalmique et paralysies oculaires, J. belge de neurol. et de psychiat. **36**:8, 1936.

Signe d'Argyll Robertson et zona ophtalmique, ibid. **36**:17, 1936.

Frazier, C. H.: Neuralgias of Trigeminal Tract and Facial Neuralgias of Other Origin, Ann. Otol., Rhin. & Laryng. **30**:855, 1921.

Frei, M.: Ueber die Beziehungen zwischen Herpes zoster und Varizellen, Jahrb. f. Kinderh. **92**:281, 1920.

Freund, H.: Beiträge zur Kenntnis von Herpes und Zoster, Arch. f. Dermat. u. Syph. **155**:282, 1928.

Friedenwald, J. S.: Report of Case of Herpes Zoster Ophthalmicus Treated with Convalescent Serum, Bull. Johns Hopkins Hosp. **45**:103, 1929.

Friedreich, cited by Zeeman.

Fuchs, E.: Text-Book of Ophthalmology, translated by A. Duane, Philadelphia, J. B. Lippincott Company, 1924, p. 657.

Galezowski, J.: Zona ophtalmique avec paralyse de la musculature intrinsèque de l'oeil et du droit externe, Rec. d'opht. **28**:178, 1906.

——and Beauvois, A.: Paralysies de la VI^e^ paire et ténonite dans de zona ophtalmique, ibid. **28**:654, 1906.

Gallemaarts: Zona ophtalmique chez une enfant de 5 ans, Ann. d'ocul. **96**:128, 1919.

Gallenga, C.: Dell'erpete, Clin. mod. **1**:366, 1895.

Gallois, J.: Zona ophtalmique compliqué de ptosis double, Paris rséd. **2**:43, 1924.

Zona ophtalmique atypique compliqué de paralysie bilatérale du domaine de la troisième paire, Ann. d'ocul. **161**:536, 1924.

Ganguly, S. K.: Case of Herpes Zoster Ophthalmicus, Indian M. Gaz. **56**:211, 1921.

Gardilčić, A.: Perineuritis und Periarteritis ciliaris bei einem frischen Fall von Herpes zoster ophthalmicus, Ztschr. f. Augenh. **92**:35, 1937.

Gasper, in Wood, C. H.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1916, vol. 8, p. 5892.

Gebb, H.: Salvarsan bei Herpes zoster ophthalmicus, Med. Klin. **10**:1096, 1914; Clin. opht. **20**:50, 1914-1915.

Genet, L.: Mydriase et fixité pupillaire consécutives à un zona ophtalmique, Lyon méd. **136**:51, 1925.

Irregularité fixité pupillaire et troubles de coloration de l'iris dans le zona ophtalmique, ibid. **153**:456, 1934.

Lésions épisclérales au cours du zona ophtalmique, ibid. **139**:137, 1927.

Taches scléroticales ardoisées, suite de zona ophtalmique, ibid. **140**:113, 1927.

Lésions de ophtalmique ganglion et zona, Bull. Soc. d'opht. de Paris, 1924-1925, p. 85.

Episclérite zostérienne, ibid., 1934, p. 344.

Gerson, L.: Zona ophtalmique et herpès chez un syphilitique récent: Contagiosité de ces deux affections, Bull. Soc. franç. de dermat. et syph. **44**:1084, 1937.

Gifford, S. R.: Handbook of Ocular Therapy, Philadelphia, Lea & Febiger, 1932, p. 125.

——and Lucic, L. H.: Sympathetic Uveitis Caused by Virus of Herpes Simplex, J. A. M. A. **88**:465 (Feb. 12) 1927.

Gilbert, W.: Ueber Herpes irides, Klin. Monatsbl. f. Augenh. **49**:649, 1911.

Klinisches und Anatomisches zur Kenntnis der herpetischen Augenkrankung, Arch. f. Augenh. **89**:23, 1921; Internat. M. & S. Survey **3**:396, 1922.

Herpes und Auge, Ergebn. d. allg. Path. u. path. Anat. **21**:1, 1928.

Ueber herpetische Erkrankungen des Uvealtraktus, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch., 1912, p. 101.

Gillet de Grandmont: Zona ophtalmique, mydriase, conjonctivite, Bull. Soc. de méd. prat. de Paris, 1873, p. 153.

Gillette: Zona du front et de la face (zona d'origine ophthalmique) kérato-conjonctivite de l'oeil gauche, Union méd. **13**:913, 1872.

Ginestous: Deux cas de zona ophtalmique, J. de méd. de Bordeaux **28**:332, 1898.

Zona ophtalmique infantile, ibid. **37**:393, 1907.

Ginsberg: Herpes zoster frontalis mit Keratitis neuroparalytica und Oculomotoriusparese, Centralbl. f. prakt. Augenh. **19**:133, 1895.

Giuffré, M.: Sui rapporti tra herpes simplex ed herpes zoster, Ann. di clin. med. **18**:153, 1928.

Glaubersohn, S. A.: Beiträge zur Zosterfrage, Dermat. Wchnschr. **86**:141, 1928.

——and Rabinowicz, N. N.: Beiträge zur Zosterfrage, ibid. **88**:861, 1929.

Godal, J., and Magrou, E.: Zona et vaccin antistaphylococcique, Bull. Soc. franç. de dermat. et syph. **44**:671, 1937.

Goeckerman, W. H., and Wilhelm, L. F. X.: Herpes Zoster and Herpes Simplex: Case in Which Both Appeared Simultaneously, Arch. Dermat. & Syph. **35**:868 (May) 1937.

Goldberg, F. R.: Herpes Zoster Ophthalmicus, Vestnik oftal. **12**:499, 1938.

Goldschmidt, D.: Zona ophtalmique; strabisme consécutif, Bull. et mém. Soc. méd. d. hôp. de Paris **10**:403, 1893.

Goldzieher, V.: Ein Fall von Trophoneurosis oculi nach Herpes zoster, Wien. med. Presse **38**:251, 1897.

Goodman, M. J.: Herpes Zoster: Treatment with Thiamin Chloride, California & West. Med. **51**: 105, 1939; abstracted, J. A. M. A. **113**:1518 (Oct. 14) 1939.

Goodpasture, E. W.: Intramuscular Inclusions in Experimental Herpetic Lesions of Rabbits, Am. J. Path. **1**:1, 1925.

——and Teague, O.: Experimental Production of Herpetic Lesions in Organs and Tissues of Rabbit, J. M. Research **44**:121, 1923.

Gosetti, F.: Quattro casi di herpes zoster ophthalmicus, Ann. di ottal. **2**:3, 1872-1873.

Gould, G. M.: A Peculiar Case of Herpes Zoster Ophthalmicus, Polyclinic, Philadelphia **6**:109, 1888-1889.

Gowers, cited by Griffith.

Grand: Observation de zona ophthalmique, Ann. Soc. de méd. de St. Etienne et de la Loire (1877-1880) **7**:120, 1881.

Grandclement, cited by Rollet (1928).

Grandi, G.: Cheratite disciforme in corso di "zoster oftalmico," Boll. d'ocul. **16**:768, 1937.

Gray, A. M. H.: Recurrent Herpes Zoster of the Face with Hemiatrophy, Brit. J. Dermat. **28**:46, 1916.

Greenough, F. B.: Clinical Notes on Herpes Zoster, Boston M. & S. J. **121**:549, 1889.

Greenwood, A., in discussion on Veasey.

Griffith, J.: Herpes Ophthalmicus and Its Complications, Internat. Clin. **2**:257, 1901.

Grindon, J.: Recurrent Zoster, J. Cutan. & Genito-Urin. Dis. **13**:191 and 252, 1895.

Grindon, J., Jr.: Herpes Zoster with Generalized Eruption, Arch. Dermat. & Syph. **39**:865 (May) 1939.

Grüter, W.: Erfahrung mit Kurzwellenbehandlung beim Ulcus serpens corneae und bei herpetischen Erkrankungen des Auges, Klin. Monatsbl. f. Augenh. **95**:605, 1935.

Die Pathogenese des Herpes ophthalmicus, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **52**:148, 1938.

Patogenesi dell'herpes oftalmico, Riv. oto-neuro-oftal. **17**:588, 1940.

Guglianetti, L.: L'erpete della cornea nell'attuale febbre epidemica, Gior. di méd. mil. **66**:903, 1918.

Guillain, G.; Lagrange, H., and Périsson, J.: Signe d'Argyll-Robertson unilatéral consécutif a un zona ophtalmique, Bull. Soc. d'opht. de Paris, 1926, p. 227.

Gundersen, T.: Convelescent Blood for Herpes, Tr. Am. Ophth. Soc. **33**:508, 1935.

Convalescent Blood for Treatment of Herpes Zoster Ophthalmicus, Arch. Ophth. **24**:132 (July) 1940.

Herpes Corneae, ibid. **15**:225 (Feb.) 1936.

Vascular Obliteration for Various Types of Keratitis: Its Significance Regarding Nutrition of Corneal Epithelium, ibid. **21**:76 (Jan.) 1939.

Herpes Zoster with Ocular Involvement, Am. J. Ophth. **16**:55, 1933.

Gunn, M., in discussion on Mules (1901), p. 295.

Habran, J.: Zona ophthalmique, Union méd. et scient. du nordest **1**:273, 1877.

Hagino, R.: Unusual Case of Herpes Zoster Ophthalmicus, Chuo. Ganka Iho **28**:29, 1936.

Haitz: Herpes zoster und akutes Glaukom als Unfallfolge, Klin. Monatsbl. f. Augenh. **95**:809, 1935.

Haldimann, C.: Sympathische Ophthalmie und Keratitis herpetica, Ophthalmologica **99**:187, 1940.

Halipré, A.: Zona sous-orbitaire, Rev. méd. de Normandie, 1910, p. 97.

Hall, A.: Herpes of Left Upper Division of Fifth Nerve with Ocular Paralysis, Brit. J. Dermat. **15**: 311, 1903.

Hallam, H.: Case of Bilateral Herpes Zoster of Trifacial Nerve, Quart. M. J. **6**:123, 1897-1898.

Halphen, E.: Zona ophtalmique et anesthésie du ganglion sphénopalatin, Rev. d'oto-neuro-ocul. **3**:770, 1925.

Haltenhoff, G.: Deux cas rares de zona ophtalmique, Ann. d'ocul. **109**:260, 1893.

Hamne, B.: Relation Between Herpes Zoster and Varicella, Svenska läk.-tidning. **35**:1479, 1938.

Harlan, cited by Wood, C. A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1916, vol. 8, p. 5892.

Harris, J. B.: Coincident Zoster and Varicella, Brit. M. J. **1**:692, 1931.

Harris, W.: Persistent Pain in Lesions of Peripheral and Central Nervous System, Brit. M. J. **2**:896, 1921.

Hasner, cited by Wilbrand and Saenger, p. 82.

Head, H.: Herpes Zoster or Zona, in Allbutt and Rolleston, 1899, vol. 8, p. 616.

On Disturbances of Sensation with Especial Reference to the Pain of Visceral Disease, Brain **16**:1, 1893.

——and Campbell, A. W.: Pathology of Herpes Zoster and Its Bearing on Sensory Localization, ibid. **23**: 353, 1900; cited by Römer, p. 654.

Hebra, cited by Jeffries (1873) and by Wheelock.

Heidingsfeld, M. L.: Herpes Zoster Ophthalmicus, Lancet-Clinic **55**:524, 1905.

Heilbrun, cited by Gilbert (1912).

Hermann, P.: Signe d'Argyll-Robertson persistant trois ans après un zona ophtalmique, Bull. Soc. d'opht. de Paris, 1935, p. 226.

Herpes Zoster Ophthalmicus, in Wood, C. A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1916, vol. 8, p. 5882.

Hervé: Zona ophtalmique chez une tuberculeuse à la troisème période, Bull. Soc. d'anat. et physiol. de Bordeaux **18**:318, 1897; Gaz. de hôp. de Toulouse **12**:97, 1898.

Hesser, S.: Anatomic Lesions in Herpes Zoster, Acta med. Scandinav. **60**:278, 1924.

Heuyer, cited by Aurand.

Hewlett, A. W.: The Motor Complications of Herpes Zoster, California State J. Med. **4**:119, 1906.

Heydemann, J.: Die Variationen des Herpes corneae, Inaug. Dissert., Rostock, 1904.

Higgens, C.: Two Cases of Severe Frontal Herpes, Brit. M. J. **1**:1077, 1901.

Hildesheimer: Ein Fall von Herpes zoster ophthalmicus gangraenosus, Centralbl. f. prakt. Augenh. **36**:77, 1912.

Hill, N. G.: Herpes Zoster and Varicella, Brit. J. Child. Dis. **26**:193, 1929.

Hinde, A.: A Study of Herpes Zoster Frontalis seu Ophthalmicus with a Case, M. Rec. **30**:285, 1886.

Hirschberg, J.: Herpes zoster frontalis mit neuroparalytischer Hornhautzerstörung, Arch. f. Augenh. **8**:166, 1879.

Höfer: Ein Fall von Herpes zoster gangraenosus trigemini mit innerer Oculomotoriuslähmung, Ann. d. städt. allg. Krankenh. zu München (1893) **7**:138, 1895.

von Hoffmann: Herpes zoster ophthalmicus, Tagebl. d. Versamml. deutsch. Naturf. u. Aerzte **52**:337, 1879; Med.-Chir. Centralbl. **15**:484, 1880.

Hollander, E.: Dependence of Sensation of Pain on Cutaneous Impulses, Arch. Neurol. & Psychiat. **40**: 743 (Oct.) 1938.

Holzer, W. F.: Unusual Corneal Opacity: Persistent Spreading Opacity Following Herpes Zoster Corneae, Tr. Am. Ophth. Soc. **31**:42, 1933.

Horner: Ueber Herpes corneae, Klin. Monatsbl. f. Augenh. **9**:321, 1871.

Horstmann: Herpes zoster frontalis s. ophthalmicus, Charité-Ann. **3**:703, 1878.

Howard, A. W.: Ptosis Following Herpes Frontalis, Lancet **2**:850, 1894.

Howse, cited by Königstein.

Hubsch: Herpes zoster général chronique; atrophie blanche des papilles des deux yeux, Ann. d'ocul. **67**:237, 1872; Presse méd. **24**:376, 1872; cited by Jessop.

Huguet: Observation de zona ophthalmique, Ann. Soc. méd.-chir. de Liége **16**:236, 1877.

Hunt, J. R.: Herpetic Inflammations of the Geniculate Ganglion, J. Nerv. & Ment. Dis. **34**:73, 1907.

The Paralytic Complications of Herpes Zoster of the Cephalic Extremity, J. A. M. A. **53**:1456 (Oct. 30) 1909.

The Symptom-Complex of Acute Posterior Poliomyelitis of the Geniculate, Auditory, Glossopharyngeal and Pneumogastric Ganglia, Arch. Int. Med. **5**: 631 (June) 1910.

Hunter, S. R.: Coincident Zoster and Varicella, Queries and Answers, Brit. M. J. **1**:610, 1931.

Hutchinson, J.: Clinical Report on Herpes Zoster Frontalis seu Ophthalmicus, Ophth. Hosp. Rep. **3**: 72, 1864; **5**:191, 1865-1866; **6**:181, 1867-1869.

Herpes Zoster of the Supra-Orbital Nerve, ibid. **5**: 331, 1865-1866.

Cases Illustrating the Connection of the Fifth Nerve with Nutrition of Eye-Ball, ibid. **4** (pt. 2):189, 1863-1865.

Herpes on the Forehead, ibid. **6**:46, 1867-1869.

Paralysis of the Right Fifth Nerve Fifteen Years After Syphilis, ibid. **6**:148, 1867-1869.

On Certain Rare Diseases of Skin, in Lectures on Clinical Surgery, London, J. & A. Churchill, 1878, vol. 1, pt. 1, p. 126.

Herpes Zoster Frontalis et Trochlearis, Lancet **1**: 619, 1879.

Exemption of Oculo-Nasal Nerve in Herpes of Forehead, Brit. M. J. **2**:8, 1891.

Remarkable Coincidence in the Occurrence of Three Cases of Herpes Frontalis, Arch. Surg., London **10**:286, 1899.

Hutton, P. W.: Bilateral Zoster and Zoster Varicellosus, Lancet **2**:302, 1935.

Hybord, A.: Du zona ophtalmique et des lésions oculaires, Thesis, Paris, no. 232, 1872.

Hyrti, cited by Königstein.

Iannuzzi, G.: La vitamina B_1 per infiltrazione locale nella cura dell'herpes zoster, Policlinico (sez. prat.) **48**:425, 1941.

Igersheimer: Zur Pathologie des Herpes zoster ophthalmicus, Klin. Monatsbl. f. Augenh. **79**:647, 1927.

Immerman, S. L.: Herpes Zoster in Tabes and General Paresis, J. A. M. A. **68**:1607 (June 2) 1917.

Ingvar, S.: Om vissa ögonmusklers representation i oculomotoriusstammen jämte synpunkter på zoster ophthalmicus problemet, Dansk med. Selsk. Forhandl., 1928-1929, p. 13.

Ironside, R.: Case of Left-Sided Herpes Zoster Ophthalmicus with Complete Left Oculomotor Palsy and Contralateral Hemiplegia, Tr. M. Soc. London **56**:45, 1933.

Ishiwara: Herpes Zoster Ophthalmicus with Iritis, Nippon Gankwa Gakukwai Zasshi, January 1911.

Isrel, cited by Voisin.

Jaksch, R.: Zur Kasuistik des Herpes zoster frontalis, Inaug. Dissert., Breslau, 1869; cited by Horner, p. 323.

Jaclard, V.: Contribution à l'étude de l'herpes ophthalmicus, Inaug. Dissert., Geneva, Ziegler & Co., 1874.

Jacobi, O.: Beitrag zur Frage des ätiologischen Zusammenhangs zwischen Varicellen und einzelnen Fällen von Herpes zoster, Ztschr. f. Kinderh. **29**:368, 1921.

Jacobson, H. P.: Treatment of Herpes Zoster, California & West. Med. **24**:46, 1926.

Jacqueau, cited by Rollet and Bussy.

Jacquet, L.: Zona ophtalmique et névralgie du nerf facial consécutifs à l'iodure de potassium, Rev. gén. d'opht. **17**:333, 1898.

Jacquet, P., and Bariéty, M.: Zona ophtalmique et syndrome oculosympathique, Bull. et mém. Soc. méd. d. hôp. de Paris **50**:1561, 1926; abstracted, J. A. M. A. **88**:207 (Jan. 15) 1927.

Jatoba, H.: Zoster Ophthalmicus in Child, Pediat. e Puericult. **5**:48, 1936.

Jeffries, B. J.: Case of Herpes Zoster Ophthalmicus in Patient Nearly 80 Years of Age, Tr. Am. Ophth. Soc. (1867-1868) **4-5**:75, 1869.

Three Cases of Herpes Zoster Frontalis seu Ophthalmicus, ibid. (1870) **7**:101, 1871.

Two Cases of Herpes Zoster Ophthalmicus Destroying the Eye, ibid. **2**:73, 1873.

Six Cases of Herpes Zoster Ophthalmicus, ibid. **2**: 221, 1874.

Jessop, W. H.: Affections of Eye in Herpes Facialis, Tr. Ophth. Soc. U. Kingdom **6**:390, 1885-1886.

Johansson, E.: Impletol in der Ophthalmologie, Ztschr. f. Augenh. **90**:301, 1936.

Johnen: Herpes zoster ophthalmicus; Iritis; Ulcus corneae, Deutsche Klin. **20**:228, 1868.

Ein weitere Notiz zum Herpes zoster im Bereiche des Nervus trigeminus, ibid. **22**:89, 1870.

Jorissenne, G.: Observations de zona ophthalmique et d'herpes, avec des considérations sur leur étiologie, Ann. Soc. méd.-chir. de Liége **14**:281, 1875.

Réflexions sur un cas de zona ophtalmique et sur son traitement, ibid. **25**:349, 1886.

Joseph, M., cited by Hoennicke, E.: Die Häufigkeit des Herpes zoster, Berl. klin. Wchnschr. **38**:786, 1901.

Juler, F.: Hypotony Following Herpes Zoster Ophthalmicus with Lid Suture, Tr. Ophth. Soc. U. Kingdom **48**:179, 1928.

Junius: Neuere Ansichten über den Herpes zoster traumaticus, Ztschr. f. Augenh. **46**:74, 1920.

Kaposi, M.: Zur Aetiologie des Herpes zoster, Med. Jahrb., 1876, p. 55.

Pathology and Treatment of Diseases of the Skin, translated by J. C. Johnston, New York, W. Wood & Co., 1895.

Kashima, J.: Experimental Study of Effects of Herpes Zoster Virus on Cornea and Testicles of Rabbit, J. Chosen M. A. (Abstr. Sect.) **30**:66, 1940.

Kawamoto, K.: Zona Covering the Cornea, Nippon Gankwa Gakukwai Zasshi **3**:26, 1899.

Keichline, J. M.: Sixty-Two Cases of Herpes Zoster Treated with X-Rays, Radiology **22**:372, 1934.

Keining, E.: Beitrag zur Zosterfrage unter besonderer Berücksichtigung des Zoster generalisatus, Dermat. Wchnschr. **86**:665, 1928.

Kendall, A. J.: Ueber Herpes corneae, Inaug. Dissert., Zurich, Zürcher u. Ferrer, 1880.

Kennon, W. G.: Herpes Zoster Ophthalmicus Complicated by Acute Glaucoma, Am. J. Ophth. **11**:477, 1928.

Kinnicutt, F. P.: Case of Zoster Frontalis Traumaticus, Arch. Dermat. **3**:128, 1877.

Kirisaua, N.: Herpes Zoster Ophthalmicus with Oculomotor Paralysis, Acta Soc. ophth. japon. **39**:2293, 1936.

Klauber, E.: Herpes zoster ophthalmicus mit Keratitis neuroparalytica und exsudativer Iritis, Wien. klin. Wchnschr. **31**:1048, 1918.

Klinedinst, J. F.: Herpes Zoster Ophthalmicus, Pennsylvania M. J. **21**:752, 1918.

Klippel and Aynaud: La paralysie faciale zostérienne, Rev. gén. de clin. et de thérap. **13**:225, 1899.

Knapp, A., in discussion on Veasey.

Knowles, F. C.: Herpes Zoster: Report of 286 Cases, with Review of the Unusual Features of the Disease, Pennsylvania M. J. **15**:615, 1911-1912.

Knox, R. A.: Herpes Zoster Ophthalmicus in Infant of 15 Months, Atlantic M. J. **31**:750, 1928.

Koch, F. L. P.: Herpes Zoster Ophthalmicus: Case in Boy 5½ Years Old, Arch. Ophth. **21**:118 (Jan.) 1939.

Kocks, J.: Ueber den Herpes zoster ophthalmicus, Inaug. Dissert., Bonn, E. Krüger, 1871.

Königstein, L.: Beitrag zur Klinik des Herpes zoster ophthalmicus, Wien. med. Presse **41**:1417, 1900.

Kolb, O.: Ueber angeborene multiple, symmetrisch gruppiert Narbenbildungen im Gesicht, Zentralbl. f. Gynäk. **33**:929, 1909.

Kooy, J. M.: Ueber das Virus des fieberhaften Herpes, Klin. Monatsbl. f. Augenh. **66**:75, 1921.

Kopp, H.: Ueber die Tropenneurosen der Haut im Anschluss an einen Fall von "neurotic excoriations," nebst Pemphigusblasen auf der Haut einer Hysterischen, Würzburg, J. Seelmeyr, 1891.

Kosminski: Herpes zoster facialis s. ophthalmicus, zona ophthalmica, Pam. Towarz. Lek. Warsaw **70**:1, 1874.

Koster, W.: Un cas de zona ophtalmique avec kératite interstitielle sans lésions épithéliales, Ann. d'ocul. **121**:96, 1899.

Kowler: Deux cas de zona ophtalmique guéris en 6 et 9 jours par des badigeonnages au Bonain du cornet moyen en entier, Ann. d'oto-laryng. **12**:1097, 1937.

Kozlowski, B.: Herpes Zoster Ophthalmicus from Carbon Monoxide Gas, Klin. Oczna **16**:176, 1938.

Kreibich, C.: Die Angioneurosen und die hämatogenen Hautentzündungen, Wien. Arch. f. Dermat. u. Syph. **95**:405, 1909.

Kreibig, W.: Histologische Beifunde Herpes zoster ophthalmicus, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **52**:461, 1938.

Kroll, W.: Ein Beitrag zur Lehre von der Keratitis neuroparalytica, Centralbl. f. prakt. Augenh. **6**:72, 1882.

Kuchner, K.: Uebertragungsversuche mit Herpesvirus, Klin. Monatsbl. f. Augenh. **91**:485, 1933.

Kuhn, cited by Voisin.

Kundratitz, K.: Experimentelle Uebertragung von Herpes zoster auf den Menschen und die Beziehungen von Herpes zoster zu Varicellen, Monatschr. f. Kinderh. **29**:516, 1925.

Zur Frage der gemeinsamen Aetiologie der Varizellen und des Herpes zoster, Wien. med. Wchnschr. **77**: 771, 1927.

Lafon, C., and Villemonte: Deux cas de zona ophtalmique suivis de kératite neuroparalitique tardive, J. de méd. de Bordeaux **36**:833, 1906.

Lagarde: De l'herpes produit par la névrite du nerf ophthalmique, Gaz. d. hôp. **47**:147, 1874.

Lampert: Quelques considérations sur le zona et le herpes fébrile, Rev. d'oto-neuro-ocul. **1**:709, 1923.

Landis, J. E.: Herpes Zoster Ophthalmicus Apparently Due to Chronic Frontal Sinusitis, Pennsylvania M. J. **32**:765, 1929.

Landtau, G. H.: Ein Fall von Herpes zoster ophthalmicus nach Trauma, Inaug. Dissert., Kiel, H. Fiencke, 1911.

Lane, L. A., in discussion on Badeaux (1935b), p. 68.
de Lange, C.: Herpes and Varicella, Nederl. tijdschr. v. geneesk. **1**:1634, 1923.
Langenhan: Herpes zoster ophthalmicus mit gleichseitiger isolierter Abducenslähmung, Ztschr. f. Augenh. **23**:522, 1910.
Laqueur: Etude sur l'herpès zoster frontal ou ophthalmique, Ann. de dermat. et syph. **2**:417, 1870.
Lauber, H.: Ein Fall von Herpes zoster ophthalmicus, Arch. f. Ophth. **55**:564, 1905.
Skleritis nach Herpes zoster ophthalmicus, Klin. Monatsbl. f. Augenh. **52**:284, 1914; cited by Meller: Zur Klinik und pathologischen Anatomie des Herpes zoster uveae, ibid. **63**:754, 1919.
Herpes zoster im 1. Trigeminusast, Wien. med. Wchnschr. **70**:2026, 1920.
Lederer, R.: Herpes zoster ophthalmicus ohne Hautaffection, Centralbl. f. prakt. Augenh. **24**:232, 1900.
Le Feuvre, W. P.: Aberrant Vesicles of Herpes Zoster, M. J. South Africa **13**:133, 1917-1918.
A Plea for Recognition of a Common Origin for Shingles and Chickenpox, Brit. J. Dermat. **29**:253, 1917.
Leopold, G.: Kasuistischer Beitrag zur Kenntnis des Herpes zoster ophthalmicus, Inaug. Dissert., Tübingen, F. Pietzker, 1904.
Lépine, J.; Christy, H., and Feuillade, M.: Zona ophtalmique et hémiplégie croisée, Lyon méd. **149**:424, 1932.
Leplat, G.: Zona ophtalmique avec parésie de tous les muscles oculaires et névrite optique rétrobulbaire du même côté, Bull. Soc. belge d'opht., 1931, no. 63, p. 39.
Leriche, R., and Fontaine, R.: De quelques faits physiologiques nouveaux touchant les fibres oculo-pupillaires du sympathique cervical, Presse méd. **34**: 1313, 1926.
Lesser, E.: Beiträge zur lehre vom Herpes zoster, Virchows Arch. f. path. Anat. **86**:391, 1881; cited by Sulzer, p. 419.
Letulle, M.: Sur un cas de zona ophtalmique gangréneux compliqué de paralysie faciale, Arch. de physiol. norm. et path. **9**:162, 1882; cited by Désirat.
Leudet: Le zona chronique, Arch. gén. de méd. **1**:5, 1887.
Levaditi, C.: L'herpes et le zona, Paris, Masson & Cie, 1926.
Ectodermoses neurotropes, ibid., 1922.
Lévine, J. M.: Ueber den Zusammenhang zwischen Zoster- und Varizellenvirus, Dermat. Ztschr. **70**: 346, 1935.
Lewis, J. B.: Herpes Zoster Ophthalmicus, M. J. Australia **1**:124, 1927.
Lewis, P. M.: Herpes Zoster Ophthalmicus, Uveitis, Secondary Glaucoma Relieved by Glaucosan, Am. J. Ophth. **14**:675, 1931.
Ligertwood, L. M.: Mydriasis and Cycloplegia as a Result of Herpes Zoster Ophthalmicus, Edinburgh M. J. **34**:423, 1927.
Lipschütz, B.: Investigations on Etiology of Diseases of Herpes Group, Arch. f. Dermat. u. Syph. **136**: 428, 1921.
Lister: Spreading Opacity of Cornea Following Herpes Zoster Frontalis, Tr. Ophth. Soc. U. Kingdom **21**: 31, 1901.
Lloyd, J. H., and Elliott, B.: Case of Herpes Zoster in the Distribution of Inferior Maxillary Nerve Associated with Paralysis of Facial Nerve, Internat. Clin. **1**:132, 1924.
Lloyd, R. I., in discussion on Pardee, I. H.: Herpes Zoster Ophthalmicus Luetica, Arch. Ophth. **3**:663 (May) 1930.
Herpes and Allied Conditions, ibid. **5**:499 (March) 1931; Tr. Am. Acad. Ophth. **35**:278, 1930; Am. J. Ophth. **14**:601, 1931.
Lockwood, T. C.: Case of Herpes Zoster Ophthalmicus, Maritime M. News **18**:28, 1906.
Lodge, S., and Lodge, W. O.: Herpes Zoster Ophthalmicus, Brit. M. J. **1**:1084, 1923.
Löhlein, W.: Repetitorium der Augenheilkunde, Deutsche med. Wchnschr. **56**:835, 1930.
Löwenstein, A.: Lidrandgeschwür, kruppöse Konjunktivitis, Angina und schmerzhafte, regionäre Drüsenschwellungen, Med. Klin. **29**:9, 1933.
Uebertragungsversuche mit dem Virus des fieberhaften Herpes, Klin. Monatsbl. f. Augenh. **64**:15, 1920.
Lomer: Herpes Zoster in an Infant, Brit. J. Dermat. **2**:28, 1890.
Low, R. C.: Herpes Zoster: Its Cause and Association with Varicella, Brit. M. J. **1**:91, 1919.
Lucie, H.: Herpes Zoster Ophthalmicus, Am. J. Ophth. **13**:1004, 1930; cited by Williamson-Noble.
Luger, A., and Lauda, E.: Zur Aetiologie des Herpes zoster, Centralbl. f. Bakt. (Abt. 1) **91**:205, 1924.
Ein Beitrag zur Frage der Uebertragbarkeit des Herpes zoster auf das Kaninchen, Ztschr. f. Hyg. u. Infektionskr. **94**:206, 1921.

McCulloch, J. D.: Case of Herpes Zoster Ophthalmicus with Paralysis of Sixth Nerve, Tr. Ophth. Soc. U. Kingdom **45**:933, 1925.
MacDonald, A. E.: Recent Advances in Care of the Insensitive Cornea, Arch. Ophth. **24**:182 (July) 1940.
McDowell, M. M.: Use of Cobra Venom for Relief of Pain in Herpes Zoster, M. Rec. **153**:173, 1941.
McEwen, E. L.: Association of Herpes Zoster and Varicella, Arch. Dermat. & Syph. **2**:205 (Aug.) 1920.
MacGillivray, A. G.: Herpes Zoster and Encephalitis, Brit. M. J. **2**:895, 1931.
Machek, E.: Ueber Herpes zoster der Regenbogenhaut im Verlaufe von Herpes zoster frontalis, Arch. f. Augenh. **31**:1, 1895.
Mackenzie, F. M.: Herpes Frontalis, Indian M. Gaz. **4**:164, 1869.
Mackenzie, G. W., in discussion on Herpes Zoster of the Cephalic Extremity, Pennsylvania M. J. **32**:644, 1929.
MacNab, A.: Herpes Zoster Nasalis, Ophthalmoscope **5**:633, 1907.
Ionic Medication in Herpes Zoster, Lancet **1**:821, 1913.
McMullen, cited by Paton (1926).
McMurray, J. B.: Herpes Zoster Ophthalmicus in Infant of 15 Months, Am. J. Ophth. **11**:51, 1928.
Magitot, cited by Genet (1924-1925).
Magnus, V.: Et tilfaelde af Herpes zoster efterfulgt af muskelatrofi, Norsk mag. f. lægevidensk. **17**:517, 1902.
Sur trois cas d'herpès zoster suivis de perturbations motorielles, ibid. **1**:877, 1903.
Herpes Zoster with Changes of the Spinal Cord, ibid. **4**:1429, 1906.
Maillet-Guy: Ophthalmomalacia et zona ophtalmique, Medical Department, University of Lyon, 1923.
Mann, I., and Baker, D.: Agranulocytic Anaemia Following Herpes Zoster Ophthalmicus, Brit. J. Ophth. **18**:458, 1934.
Mariani, G.: Keratitis and Herpetic Meningo-Encephalitis, abstracted, Internat. M. & S. Survey **4**:559, 1922.
Marinesco and Draganesco: Physiologie pathologique du zona zoster, Ann. d'ocul. **160**:743, 1923.
Marlow, cited by Lloyd (1931).

Márquez, M.: Zona oftálmico, Arch. de oftal. hispano-am., June 1905, vol. 5.

Martini: Du zona ophtalmique, Rec. d'opht. **3**:150, 1876.

Mathewson, A.: Treatment of Herpes Zoster by Electricity, Tr. Am. Ophth. Soc. **2**:228, 1874.

May, G. A.: Herpetic Keratitis, J. Iowa M. Soc. **20**:16, 1930.

Mayou, M. S.: Two Cases of Herpes Zoster Affecting Ciliary Nerves, Tr. Ophth. Soc. U. Kingdom **37**: 226, 1917.

Mehlis, cited by Head.

Meller, J.: Zur Klinik und pathologischen Anatomie des Herpes zoster uveae, Ztschr. f. Augenh. **43**:450, 1920.

Ueber die Perineuritis und Periarteritis ciliaris bei Herpes zoster ophthalmicus, ibid. **50**:2, 1923.

Menacho, M.: Zona oftálmico-combinado con paralisis parcial del 3er par, Arch. de oftal. hispano-am. **2**:562, 1902.

Metz, R. B.: Herpes Zoster Ophthalmicus Complicated by Ophthalmoplegia, Ohio M. J. **9**:590, 1913.

Michel, in Graefe, A., and Saemisch, T.: Handbuch der gesamten Augenheilkunde, Leipzig, Wilhelm Engelmann, 1907, vol. 4, p. 397.

Herpes zoster frontalis ou zona ophtalmique, Arch. méd. belges **28**:150, 1885.

Michelsen: Alkoholinjektion bei Herpes zoster ophthalmicus, Klin. Monatsbl. f. Augenh. **88**:236, 1932.

Mildenberger: Ein Fall von Herpes zoster mit Paresen des Oculomotorius des Trochlearis und Abduzens, Klin. Monatsbl. f. Augenh. **98**:104, 1937.

Milian, G., cited by Lloyd (1931).

Le traitement du zona par le 914, Bull. Soc. franç. de dermat. et syph. **39**:1250, 1932.

——and Chapireau: Zona ophtalmique et signe d'Argyll Robertson unilatéral, Bull. et mém. Soc. méd. d. hôp. de Paris **51**:1743, 1935.

Mittendorf, W. M.: Diseases of the Eye Dependent on Herpes Zoster Frontalis, Polyclinic, Philadelphia **5**:129, 1887-1888.

Moers: Herpes zoster facialis bilaterales, Deutsches Arch. f. klin. Med. **3**:162, 1867.

Molter, A.: Ueber die Sensibilitätsverhältnisse der menschlichen Cornea, Inaug. Dissert., Cassel, T. Fischer, 1878.

Monnier, cited by Voisin.

Montalti: Contribuzione all'etiologie dell'herpes, Atti Cong. d'oftal., 1927, p. 194.

Montgomery, D. W.: Zoster Ophthalmicus with Paresis of the Facialis, Occidental M. Times **14**:109, 1900.

The Course of Virus of Herpes Zoster Takes to Reach the Nerve Ganglion, J. Cutan. Dis. **31**:156, 1913.

——and Culver, G. D.: A Comparison Between Zoster of the Face and That of the Leg as Shown in Two Cases Recently Observed, J. A. M. A. **60**:1692 (May 31) 1913.

Moore, R. F.: Ocular Manifestations of Lesions of the Fifth Cranial Nerve, Brit. M. J. **2**:783, 1932.

Moore, W. O.: Herpes Zoster and Ophthalmic Shingles, Internat. Clin. **3**:312, 1895.

Morax, V.: Précis d'ophtalmologie, Paris, Masson & Cie, 1907, p. 56.

Complications glaucomateuses au cours du zona ophtalmique, Ann. d'ocul. **153**:73, 1916.

Morénas, L., and Colrat, A.: Paralysies oculaires et zona dorsolombaire, J. de med. de Lyon **13**:177, 1932.

Moret: Primary Interstitial Keratitis in Ophthalmic Zona, Medical Department, University of Lyon, 1930.

Mules, P. H.: Paralysis of Third Nerve with Unusual Complications, Tr. Ophth. Soc. U. Kingdom **21**: 292, 1901.

Three Cases of Paralysis of Ocular Muscles Following Herpes Zoster Frontalis, Lancet **1**:524, 1903.

Murphy, H. H.: Herpes Zoster of Face with Paralysis, Brit. M. J. **2**:466, 1897; Monatsh. f. prakt. Dermat. **27**:484, 1898; cited by Griffith.

Murzin, A. N.: Ocular Changes in Herpes Zoster Ophthalmicus, Vestnik oftal. **11**:758, 1937.

Myers, cited by Paton (1926).

Neame, H.: Association of Dendritic Ulcer of Cornea and of Superficial Punctate Keratitis with Herpes Facialis, Brit. J. Ophth. **21**:298, 1937.

Affections of Eye Due to Virus, Tr. Ophth. Soc. U. Kingdom **51**:24, 1931.

Neligan, J. M.: A Practical Treatise on Diseases of the Skin, Philadelphia, Blanchard & Lea, 1852, p. 88; cited by Rohé, G. H.: Pathology of Herpes Zoster, Arch. Dermat. **3**:318, 1877.

Netter, A., in discussion on Comby, J.: Varicelle et zona, Bull. et mém. Soc. méd. d. hôp. de Paris **52**:1009, 1928.

——and Ernoul, J.: Zona dans le territoire du médian gauche vingt-six jours après une légère piqûre a l'extrémité du median gauche au cours d'une éviscération d'un globe oculaire atteint de fonte purulente de la cornée suite d'un zona ophtalmique, ibid. **50**:798, 1934.

——and Urbain, A.: Zonas varicelleux; anticorps varicelleux dans le sérum de sujets atteints de zona; anticorps zostériens et anticorps varicelleux dans le sérum de sujets atteints de varicelle, Compt. rend. Soc. de biol. **90**:189, 1924.

Réaction de fixation dans un zona arsenical et dans 2 zonas après injection de bismuth, ibid. **90**:997, 1924.

Relations Between Herpes Zoster and Chickenpox: Serologic Study of One Hundred Cases of Herpes Zoster, ibid. **94**:98, 1926.

Nicolau, P., and Drăganescu, S.: Zona zoster ophtalmique et paralysie totale de l'oculo-moteur commun, Rev. d'oto-neuro-opht. **14**:479, 1936.

Nieden, A.: Ein Fall von recidivirendem Herpes zoster ophthalmicus, Centralbl. f. prakt. Augenh. **6**:161, 1882.

Niles, H. D.: Herpes Zoster: Report of Case of Palm and Two Fingers, and Fifteen Other Cases, Treated with Pituitrin, New York State J. Med. **32**:773, 1932.

Nitzulescu, J., and Triandaf, E.: Treatment of Herpetic Keratitis with Vitamin B, Brit. J. Ophth. **21**:654, 1937.

Nobl, G.: Zur Kenntnis des Herpes zoster generalisatus, Wien. klin. Wchnschr. **24**:14, 1911.

Noyes, H. D.: Herpes Zoster Ophthalmicus of Left Side Causing Loss of Corresponding Eye and Subsequent Loss of Other Eye, Tr. Am. Ophth. Soc. **2**:71, 1873.

Nyáry, L.: Beiträge zur Pathologie des Herpes zoster, Deutsche Ztschr. f. Nervenh. **68-69**:242, 1921; Neurol. Centralbl. **40**:263, 1921.

Oettinger, C., cited by Wilbrand, H., and Saenger, A.: Neurologie des Auges, Munich, J. F. Bergmann, 1901, vol. 2, p. 1810.

Oliver, C. A.: Clinical Report of a Case of Herpes Zoster Ophthalmicus Involving First Division of Left Fifth Nerve, New York M. J. **90**:855, 1909.

Ollivier, A.: Quelques réflexions sur la pathogénie de l'angine herpétique à propos d'un cas de zona de la face, Gaz. méd. de Paris **27**:533, 1872.

Ormsby: Generalized Herpes Zoster Associated with a Varicelloid Eruption, J. Cutan. Dis. **29**:308, 1911.

Orr, D., and Rows, R. G.: Lymphogenous Infections of Central Nervous System, Brain **36**:271, 1914.

Osterroht: Herpes zoster ophthalmicus, Samml. zwangl. Abhandl. a. d. Geb. d. Augenh. (no. 1) **7**:1, 1907.

Ozawa: Two Cases of Ophthalmic Herpes Zoster, Nippon Gankwa Gakukwai Zasshi **7**:906, 1903.

Pacheco: Lesiones oculaires consecutivas a las injecciones de vaccina antitifoldica, Arch. de oftal. hispano-am. **18**:577, 1918.

Pacton, M.: Du zona ophtalmique, Thesis, Paris, no. 216, 1878.

Padovani, S.: Zoster oftalmico e varicella, Lettura oftal. (no. 12) **11**:475, 1914.

Paget, J.: Case of Herpetic Eruption in Part of the Distribution of Second Division of Right Fifth Cerebral Nerve, Brit. M. J. **2**:402, 1866.

Paillard, H.: Travaux récents sur l'auto-hémothérapie, J. méd. franç. **12**:437, 1923.

Palazzi, S.: A proposito di un caso di herpes zoster della regione fronto-orbitaria, Osp. maggiore **9**:152, 1921.

Pantol: Primary Glaucoma in Course of Ophthalmic Zona, Medical Department, University of Lyon, 1932.

Pardee, I.: Herpes Zoster Ophthalmicus Luetica, Arch. Ophth. **3**:748 (June) 1930.

Parisot, J., and Simonin, P.: Deux cas de zona guéris par l'autohémothérapie, Bull. Soc. franç. de dermat. et syph. (Réunion dermat., Nancy) **30**:26, 1923.

Parker, W. R., in discussion on Veasey.

Parounagian, M. B., and Goodman, H.: Herpes zoster Generalisatus, Arch. Dermat. & Syph. **7**:439 (April) 1923.

Parrot, J.: Considérations sur le zona, Union méd., Paris **10**:109, 117 and 121, 1856.

Parsons, J. H.: The Nerve Supply of the Lacrymal Gland, Roy. London Ophth. Hosp. Rep. **15** (pt. 2): 81, 1902.

Herpetic and Allied Affections of Cornea, Lancet **1**: 1412, 1907.

Paschen, E.: Weitere Mitteilungen über Vakzinsviruszüchtung in der Gewebekultur: Elementarkörperchen im Bläscheninhalt bei Herpes zoster und Varizellen, Zentralbl. f. Bakt. (Abt. 1) **130**:190, 1933.

Züchtung des Ektromelievirus auf der Chorion-Allantois-Membran von Hühnerembryonen, ibid. **135**: 445, 1936.

Passera, E.: Herpes zoster bilateral nei territori del primo e secondo ramo del nervo trigemino, Gior. di med. mil. **60**:161, 1912.

Paton, L.: Optic Atrophy After Herpes Ophthalmicus, Proc. Roy. Soc. Med. (Sect. Ophth.) **16**:27, 1922-1923; Am. J. Ophth. **6**:508, 1923.

Trigeminal and Its Ocular Lesions (Herpes Simplex Corneae, Herpes Zoster Ophthalmicus and Neuropathic Keratitis), Brit. J. Ophth. **10**:305, 1926.

Patterson, J. A., cited by Hunt (1909).

Pearce, T. V.: Herpes Ophthalmicus Following Chorea and Associated with Varicella, Brit. M. J. **1**:782, 1930.

Peet, M. M.: Postherpetic Trigeminal Neuralgia: Persistence of Pain After Section of Sensory Root of Gasserian Ganglion, J. A. M. A. **92**:1503 (May 4) 1929.

Pendergrass, E. P., in discussion on Badeaux (1935b), p. 68.

Penman, G. G.: Scleritis as a Sequel of Herpes Ophthalmicus, Brit. J. Ophth. **15**:585, 1931.

Perdrau, J. R.: Affections of Eye Due to Virus, Tr. Ophth. Soc. U. Kingdom **51**:3, 1931.

Pergola, A.: Su di un caso di erpete della cornea associato a sindrome di Claude Bernard-Hörner, Rassegna ital. d'ottal. **8**:197, 1939.

Complicazioni oculari nel corso di "herpes zoster oftalmicus," ibid. **8**:675, 1939.

Perrin, M.; Kissel, P.; Pierquin, L., and Gayet, P.: Hémiplegie post-zonateuse, Rev. méd. de Nancy **66**:309, 1938.

Peter, L. C.: Herpes Zoster Ophthalmicus, Pennsylvania M. J. **32**:639, 1929.

Pfingst, A. O.: Report of a Case of Herpes Zoster Ophthalmicus, Ophth. Rec. **8**:217, 1899.

Pflimlin, R.: Zur klinischen Unterscheidung verschiedener Formen des Herpes corneae, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **48**:212, 1930; abstracted, Klin. Monatsbl. f. Augenh. **85**:120, 1930.

Pflüger: Ein Fall von Herpes corneae, Klin. Monatsbl. f. Augenh. **12**:166, 1874.

Phillips, F. A.: Case of Healed Herpes Zoster Ophthalmicus with Consecutive Corneal Ulcer, J. Cutan. Dis. **25**:276, 1907.

Phillips, H. T., and Morginson, W. J.: Sodium Iodide in Treatment of Herpes Zoster, West Virginia M. J. **28**:406, 1932.

Picault: Syphilitic Zona Ophthalmicus, Medical Department, University of Lyon, 1925.

Pickard, R.: Causation of Herpes Ophthalmicus, Proc. Roy. Soc. Med. **28**:29, 1934; Arch. Ophth. **13**:138 (Jan.) 1935.

Pierron, C.: Contribution à l'étude des manifestations oculaires du zona ophtalmique, Clin. opht. **25**:133 and 193, 1921.

Pillsbury, D. M., and Fondé, G. H.: Treatment of Herpes Zoster, M. Clin. North America **20**:239, 1936.

Pitres, A., and Vaillard, L.: Contribution à l'étude des névrites périphériques non traumatiques, Arch. de neurol. **5**:191, 1883.

Pollitzer, cited by Ormsby.

Pooley: Herpes Zoster Ophthalmicus, Arch. Ophth. **30**:180, 1901.

Potts, C. S.: Paralysis of Oculopupillary Sympathetic Fibers and Ophthalmic Division of Trigeminal Nerve Preceded by Ophthalmic Herpes Zoster, Arch. Neurol. & Psychiat. **16**:71 (July) 1926.

Powell, L. S.: Herpes Zoster Ophthalmicus, Am. J. Ophth. **13**:796, 1930.

Pretori, H.: Zur Keratitis dendritica superficialis, Arch. f. Augenh. **57**:197, 1907.

Proust, R.: Considérations sur l'existence et la nature de la réaction méningée dans le zona ophtalmique, Thesis, Paris, no. 398, 1920.

Puech: Observation de zona ophtalmique, Gaz. hebd. d. sc. méd. de Bordeaux **16**:283, 1895.

Pye, cited by Königstein.

Quick, H. E., cited by Savin.

Rachmaninow, J. M.: Ueber einen Fall von Herpes zoster ophthalmicus bei einem Kinde, Arch. f. Kinderh. **45**:374, 1907.

Raecke: Ist Herpes zoster ophthalmicus als Unfallfolge aufzufassen? Aerztl. Sachverst.-Ztg. **16**:321, 1910.

Ramond, L.: Zona ophtalmique, Presse méd. **46**:163, 1938.

——and Lebel, R.: Adenite primitive du zona, Bull. et mém. Soc. méd. d. hôp. de Paris **44**:1157, 1920.

Randolph, R. L.: Herpes Zoster Ophthalmicus Resulting in Loss of Eye, Arch. Ophth. **30**:414, 1901.

Rasquin, E.: Les injections d'alcool dans le traitement des douleurs consécutives au zona ophtalmique, Bull. Soc. belge d'opht., 1928, no. 57, p. 124.

Rayer, P., cited by Evans.

Raynard, cited by Désirat.

Rea, R. L.: Neuro-Ophthalmology, St. Louis, C. V. Mosby Company, 1938, p. 351.

Rebattu, J., cited by Voisin.

Redslob, E.: Troubles pupillaires dans le zona ophtalmique, Rev. d'oto-neuro-ocul. **1**:509, 1923.

Reiser, K. A.: Veränderungen am Hornhautnervenapparat des Kaninchens nach exstirpation des Ganglion Gasseri, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **51**:287, 1936.

Renard, G.: Troubles pupillaire et zona, Bull. Soc. d'opht. de Paris, 1928, p. 555.

Les complications oculaires du zona ophtalmique, Bull. méd., Paris **46**:316, 1932.

——and Halbron, P.: À propos des rapports entre la varicelle et le zona, Arch. d'opht. **51**:151, 1934.

Reynolds, R. W.: Herpes Zoster with Report of Case Affecting Eye, Cleveland M. & S. Reporter **14**:521, 1906.

Richman, F.: Herpes Zoster Ophthalmicus, Arch. Ophth. **22**:153 (July) 1939.

Roberts, G. E.: Herpes and Varicella, Brit. M. J. **2**: 584, 1913.

Roelofs, C. O.: Ophthalmic Herpes Zoster with Complications, Nederl. tijdschr. v. geneesk. **64**:2876, 1920.

Römer, P.: Textbook of Ophthalmology, translated by M. L. Foster, New York, Rebman Co., 1912-1913.

Rokitskaya, L.: Etiology and Pathogenesis of Herpes Zoster Ophthalmicus, Sovet. vestnik oftal. **6**:453, 1935.

Roll, W.: Herpes Zoster in Child of 3 Years, Proc. Roy. Soc. Med. (Sect. Ophth.) **13**:18, 1920.

Rollet, E.: Le zona oculaire, Arch. d'opht. **37**:321, 1920.

L'iritis zostérienne, Lyon méd. **135**:715, 1925.

Les zonas ophtalmiques larvés, Arch. d'opht. **45**:667, 1928; Lyon méd. **141**:687, 1928.

——and Bussy: Le zona ophtalmique chez l'enfant, ibid. **129**:789, 1920.

——and Colrat: Zona ophtalmique et ophtalmomalacie, ibid. **132**:753, 1923.

Atrophie post-névritique du nerf optique au cours d'un zona ophtalmique, ibid. **139**:464, 1927.

Zona ophtalmique et hémiparésie alterne, Arch. d'opht. **43**:577, 1926.

——and Grand-Clément, L.: Un cas de kératite interstitielle compliquant un zona ophtalmique, Lyon méd. **115**:679, 1910.

——and Trossat: Ulcère de la cornée et hypotension oculaire apparus tardivement au cours d'un zona ophtalmique, ibid. **133**:758, 1924.

——Bujadoux and Blanc: Zona ophtalmique avec complications oculaire sensitivomotrices, chez une fillette de 9 ans ½. Varicelles consécutives dans son entourage, ibid. **147**:778, 1931.

Rollet, J.: Lésions cornéennes au cours du zona, Lyon méd. **149**:302, 1932.

——and Parthiot: Traitement des algies tardives du zona ophtalmique, Arch. d'opht. **47**:723, 1930.

Rosenak, S.: Procaine Injection in Treatment of Herpes Zoster, Lancet **2**:1056, 1938.

Rosenmayer, cited by Gilbert (1912).

Rosenow, cited by Mackenzie.

Rosenow, E. C., and Oftedal, S.: Etiology and Experimental Production of Herpes Zoster, J. Infect. Dis. **18**:477, 1916; J. A. M. A. **64**:1968 (June 12) 1915.

Rosnoblet, J.: Zona ophtalmique et paralysies associées, J. de méd. de Lyon **6**:191, 1925; Zentralbl. f. d. ges. Ophth. **15**:426, 1925-1926.

Rossander, C. J.: Herpes Zoster Ophthalmicus, Hygiea **39**:7, 1877.

Roxburgh, A. C.: Herpes Zoster and Varicella, Brit. J. Dermat. **35**:152, 1923.

Ruggles, E. W.: Apparent Specific Effects of Sodium Iodide in Herpes Zoster, Arch. Dermat. & Syph. **23**:472 (March) 1931.

Rutter, A.: Note on Ocular Paralysis Following Herpes Facialis, Lancet **1**:298, 1899.

Rychener, R. O.: Herpes Zoster Ophthalmicus, Am. J. Ophth. **22**:193, 1939.

Samelsohn, J.: Ueber vasomotorische Störungen des Auges, Arch. f. Ophth. **21** (pt. 3):29, 1875.

Saint-Martin: Complication oculo-motrices du zona ophtalmique, Bull. Soc. d'opht. de Paris, 1929, p. 39.

de Salterain, J.: Zona oftálmica en una niña, Arch. latino-am. de pediat. **14**:331, 1920.

Sasportas, L.: Contribution à l'étude du zona ophtalmique, Thesis, Paris, no. 31, 1913; abstracted, Klin. Monatsbl. f. Augenh. **52**:585, 1914.

Satanowsky, P.: Frecuencia de la queratitis parenquimatosa, Argyll-Robertson unilateral, ciclitis y glaucoma, consecutivos al zona oftálmico, Semana méd. **2**:1919, 1931.

Sattler, H.: Herpes Zoster Ophthalmicus, Irish Hosp. Gaz. **2**:199, 1874.

Ueber das Wesen des Herpes zoster ophthalmicus, Vrtljahr. f. Dermat. u. Syph. **7**:527, 1875; Wien. med. Presse **16**:1044, 1875.

Ueber einen Fall von Herpes zoster ophthalmicus, Wien. med. Wchnschr. **39**:327, 1889.

Savin, L. H.: Affection of Eye Due to Virus, Tr. Ophth. Soc. U. Kingdom **51**:22, 1931.

Discussion of Relationship, Direct or Indirect, Between Certain Cases of Herpes Ophthalmicus and Varicella, ibid. **53**:271, 1933.

Sayers, E. G.: Herpes Zoster and Varicella in the Tropics, Brit. M. J. **2**:402, 1932.

Schäffer, E.: Ueber einem Fall von Zoster ophthalmicus bei croupöser Pneumonie nebst einigen Bemerkungen über das Wesen des Herpes zoster, München. med. Wchnschr. **36**:611, 1889.

Schaller, W. F.: Spinal Fluid Findings in Herpes Zoster, California State J. Med. **16**:453, 1918.

Schamberg, J. F.: Herpes Zoster with Especial Reference to Supra-Orbital Type, Internat. M. Mag. **8**:734, 1899; cited by Ormsby.

Scheel, O.: Sur un cas de zona suivi d'autopsie, Norsk mag. f. lægevidensk. **2**:1221, 1904.

van der Scheer, W. M.: Beitrag zur Frage der Bedeutung des Herpes zoster und der Headschen hyperalgetischen Zonen, Ztschr. f. d. ges. Neurol. u. Psychiat. **16**:343, 1913; cited by Nyáry.

Schenkl: Zwei Fälle von Herpes zoster ophthalmicus, Prag. med. Wchnschr. **9**:362, 1884.

Schiess-Gemuseus: Unusual Form of Ophthalmic Herpes, Augenheilanstalt in Basel, 1880, p. 26.

Schiff, C. I., and Brain, W. R.: Herpes Zoster Associated with Acute Meningo-Encephalitis, Lancet **2**:70, 1930.

Schiffer, cited by R. D. Cohn and by Jessop.

—and Wyss, O.: Ein Fall von melanotischem Sarkom, Virchows Arch. f. path. Anat. **35**:413, 1866.

Schönfeld, W.: Zoster und Herpes simplex, in Jadassohn, J.: Handbuch der Haut- und Geschlechtskrankheiten, Berlin. Julius Springer, 1928, vol. 7, pt. 1, p. 1.

Schöpfer, O.: Ueber Abduzenslähmung im Verlaufe eines Herpes zoster ophthalmicus, Klin. Monatsbl. f. Augenh. **80**:78, 1928.

Schoeppe, H.: Ueber Herpes irides, Arch. f. Augenh. **92**:208, 1922-1923.

Schumacher, N.: Hippokrates **6**:837, 1935.

Scott, A. A. B.: Retinal Detachment Occurring After Herpes Zoster Ophthalmicus in Case of Simple Glaucoma, Brit. J. Ophth. **16**:358, 1932.

Scriven, J. B.: Herpes Zoster Frontalis, Indian M. Gaz. **4**:139, 1869.

Sears, W. H.: Herpes Zoster in Otolaryngology, Pennsylvania M. J. **32**:641, 1929.

Secunda, L.; Wolf, W., and Price, J. C.: Herpes Zoster: Local Anesthesia in Treatment of Pain, New England J. Med. **224**:501, 1941.

Sédan, J.: Hypotonies dans le zona ophtalmique, Marseille-méd. **62**:1338, 1925.

Hypotonies oculaires dans les zonas céphaliques, Rev. d'oto-neuro-opht. **11**:601, 1933.

Selinger, E.: Treatment of Dendritic Keratitis with Quinine Bisulfate, Arch. Ophth. **17**:1085 (June) 1937.

Sellers, W.: A Case of Ophthalmoplegia with Herpes, M. Chron. **5**:294, 1886-1887.

Shelmire, J. B., and Shelmire, B.: Concurrent Herpes Zoster and Varicella, Arch. Dermat. & Syph. **17**: 687 (May) 1928.

Sicard, J. A.: Un cas d'oreillons, avec zona du trijumeau et lymphocytose rachidienne, Bull. et mém. Soc. méd. d. hôp. de Paris **22**:135, 1905.

—and Robineau: Radiocotomie gassérienne, par arrachement, contre l'algie rebelle du zona ophtalmique, Rev. neurol. **29**:446, 1922.

Sichel: Die l'herpès zoster frontalis ou ophtalmique, ou zona de la face, Union méd. **12**:580, 1871.

Sidlick, D. M.: Use of Solution of Pituitary in Herpes Zoster, Arch. Dermat. & Syph. **22**:91 (July) 1930.

Sieur; Poulard, A., and others: Ophtalmologie et otologie dans la pratique médicale, Paris, A. Maloine & fils, 1922, p. 265.

Silcock, A. Q.: Demonstration on Two Cases of Herpes Ophthalmicus Associated with Paralysis of Ocular Muscles, Clin. J., London **4**:245, 1894.

Cited by Wood, C. A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1916, vol. 8, p. 5892.

Siméon and Denizet: Syndrome du ganglion géniculé (paralysie faciale et algie de l'intermédiaire de Wrisberg) avec zona du trijumeau, Rev. d'oto-neuro-ocul. **5**:667, 1927.

Sinclair, cited by R. F. Moore.

Sindhu, P. S.: Herpes Zoster Ophthalmicus with Unusual Complications, Proc. All-India Ophth. Soc. **6**:149, 1938.

Singer, M.: Herpes zoster, entsprechend den Zweigen des dritten Astes vom Nervus trigeminus, Wien. med. Wchnschr. **15**:1029, 1865.

Smith, E.: Case of Herpes Zoster Ophthalmicus, with Loss of Eye, Michigan M. News **1**:65, 1878.

Smith, W. S.: Herpes Zoster Ophthalmicus, Northwest. Lancet **16**:91, 1896.

Snell: Herpes Ophthalmicus Occurring Shortly After Extraction of Cataract, Ophth. Rev. **15**:309, 1896.

Somers, M. R., and Pouppirt, P. S.: Herpes Zoster: Some of Its Clinical Aspects, California & West. Med. **42**:370, 1935.

Sommer, I.: Herpes Zoster Ophthalmicus: Relation to Sympathetic Ophthalmia and Inner-Ear Lesion, Texas State J. Med. **26**:421, 1930.

Souquez, cited by Weill and Reys.

Sourdille, G. P., and Legrand: Zona ophtalmique: Episclérite et tuberculose, Bull. Soc. d'opht. de Paris, 1933, p. 567.

de Souza Araujo, H. C.: O herpes zoster (zona) e o seu tratamento, Acta med., Rio de Janeiro **7**:24, 1941.

Spaeth, E. B., cited by Peter.

Spicca, G.: Studio sperimentale sull'herpes zoster, Arch. ital. di dermat., sif: **4**:272, 1929.

Spicer, W. T. H.: Cicatricial Keloid After Herpes Ophthalmicus, Tr. Ophth. Soc. U. Kingdom **12**: 220, 1891-1892.

Vesicular Affections of Cornea, Ophth. Rev. **26**:315, 1907.

Spillane, J. D.: Bell's Palsy and Herpes Zoster, Brit. M. J. **1**:236, 1941.

Spillman, L., and Raspiller: L'autohémothérapie dans le zona, Bull. Soc. franç. de dermat. et syph. (Réunion dermat., Nancy) **30**:24, 1923.

Stanford, J. B.: Herpes Zoster Ophthalmicus, J. Tennessee M. A. **25**:372, 1932.

Starobypinska and Sterling, W.: Zona ophtalmique fébrile, Rev. oto-neuro-opht. **10**:49, 1932.

Stastnik, E.: Treatment of Herpes Zoster of Eye, Ceskoslov. oftal. **2**:114, 1935.

Staz, L.: Unusual Condition of the Posterior Surface of Cornea (Posterior Herpes), Brit. J. Ophth. **23**: 622, 1939.

Steffan: Herpes zoster frontalis seu ophthalmicus, Klin. Monatsbl. f. Augenh. **6**:366, 1868.

Steiger-Kazal, D.: Das Verhalten der weissen Blutzellen bei verschiedenen Dermatosen, Arch. f. Dermat. u. Syph. **154**:621, 1928.

Stellwag von Carion, K.: Ueber Herpes ciliaris und seine Beziehungen zum Zoster, in Abhandlungen aus dem Gebiete der praktischen Augenheilkunde, Vienna, W. Braumüller, 1882, p. 77; Wien. med. Bl. **5**:225 and 260, 1882.

Stelwagon, H. W.: Treatise on Diseases of the Skin, Philadelphia, W. B. Saunders & Co., 1904, p. 333.

Stephenson, F. B.: Remarks on X-Ray Treatment of Superficial Infections, Am. J. Ophth. **2**:554, 1928.

Stern, E. S.: Mechanism of Herpes Zoster, Brit. J. Dermat. **49**:263, 1937.

Stieren, E.: Herpes Zoster Ophthalmicus, Pennsylvania M. J. **9**:327, 1905-1906.

Strübing, P.: Herpes zoster und Lähmungen motorischer Nerven, Deutsches Arch. f. klin. Med. **37**:513, 1885.

Strzeminski: Complications oculaires de zona ophtalmique, Rec. d'opht. **20**:19, 1898.

Complication rare du zona ophtalmique, ibid. **26**:705, 1904.

Stuart, C. C., cited by Metz.

Stumpf, P.: Technik und Erfolge der Strahlenbehandlung in der Ophthalmologie, Arch. f. Augenh. **89**: 109, 1921.

Sulzer, D.: Contribution a l'etude du zona ophtalmique Ann. d'ocul. **119**:401, 1898.

Sulzer, G. A.: Herpes Zoster Ophthalmicus, Ophthalmology **3**:47, 1906-1907.

Sunde, A.: Herpes zoster frontalis med. bakteriefund i ganglion Gasseri, Norsk mag. f. lægevidensk. **11**: 339, 1913; translated, Deutsche med. Wchnschr. **39**: 849, 1913.

Svitzer, cited by Königstein.

von Szily, cited by Williamson-Noble.

Szokalski, W.: Herpes Zoster Ophthalmo-Facialis, Medycyna **5**:1, 1876-1877.

Tacke: Zona ophtalmique, Ann. de l'Inst. chir. de Bruxelles **10**:129, 1903.

Talko, J.: Zoster frontalis seu ophthalmicus, Med. sborn. **9**:1, 1870.

Talkovskiy, S. I.: Neurologic Factors in Dynamics of Corneal Processes Associated with Herpes Zoster Ophthalmicus, Vestnik oftal. **13**:636, 1938.

Taniguchi, T., and others: Studies on Virus of Smallpox, Jap. J. Exper. Med. **10**:581, 1932.

——Hosokawa, M.; Kuga, S., and Masuda, Z.: Virus of Herpes and Zoster, ibid. **12**:101, 1934.

Tardy, L.: Zona du front et du cuir chevelu ayant donné lieu à des troubles de la vue, J. d'opht. **1**:406, 1872.

Fall von Zoster der Stirn und des behaarten Kopfes mit Beteiligung der Auges, Jahresb. u. d. Leistung. u. Fortschr. im Geb. d. Ophth. **3**:413, 1872.

Tay, W.: Paralysis of Right Facial Nerve with Herpes Zoster of Second Division of Fifth Nerve, Brit. M. J. **2**:1246, 1883.

Teague, O., and Goodpasture, E. W.: Experimental Herpes Zoster, J. A. M. A. **81**:377 (Aug. 4) 1923.

——Goodpasture, E. W., and Lipschütz, B., cited in The Experimental Production of Herpetic Lesions, editorial, ibid. **82**:1049 (March 29) 1924.

ten Doesschate, G.: Intraocular Pressure with Ophthalmic Herpes, Am. J. Ophth. **2**:823, 1919.

Terlinck, J., Jr.: Zona ophtalmique après alcoolisation du ganglion de Gasser, Bull. Soc. belge d'opht., 1928, no. 57, p. 128.

Terrien, F.: Zona ophtalmique et kératite neuro-paralytique, Clinique **6**:678, 1911.

De la kératite parenchymateuse comme manifestation primitive du zona ophtalmique, Arch. d'opht. **20**: 449, 1900.

Zona ophtalmique et hypertension oculaire, Rev. gén. de clin. et de thérap. **42**:113, 1928.

Zona ophtalmique et traumatisme, Rev. d'oto-neuro-opht. **13**:619, 1935.

Complications oculaires du zona ophtalmique, Rev. gén. de clin. et de thérap. **48**:241, 1934.

Terson, A.: Zona ophtalmique unilateral et double keratite destructive, Bull. méd., Paris **7**:648, 1893.

Teulières, Bessière and Corcelle: Sur un cas de zona de certaines branches de l'ophtalmique et du maxillaire superieur, J. de méd. de Bordeaux **110**:110, 1933.

Thomas, E., cited by Wheelock.

Thomas, H. G.: Ophthalmic Herpes Zoster, Am. J. Ophth. **4**:853, 1921.

Thompson, G. W.: Herpes Zoster Affecting Ciliary Nerves, Am. J. Ophth. **1**:502, 1918; Brit. J. Ophth. **2**:624, 1918; abstracted, Klin. Monatsbl. f. Augenh. **62**:131, 1919.

Tikanadze, I.: Herpes Zoster Ophthalmicus, Vestnik oftal. **14**:159, 1897.

Tilney, F., and Howe, H. S.: Epidemic Encephalitis (Encephalitis Lethargica), New York, Paul B. Hoeber, 1920, p. 47.

Torino, J.: Un caso de zona oftálmica, An. Asoc. circ. méd. Argentino **2**:69, 1878-1879.

Torres, G.: Terapeutica arsenical do zona oftalmico, Arq. de clin. oftal. **3**:120, 936; **6**:97, 1939.

Touraine, A., and Baumgartner, P.: Zona ophtalmique double, Bull. Soc. franç. de dermat. et syph. **41**: 736, 1934.

Townes, C. D.: Herpes Zoster Ophthalmicus, Kentucky M. J. **26**:480, 1928.

Traquair, H. M.: Case of Paresis of Fourth Nerve Following Herpes Zoster Ophthalmicus Complicated by a Pre-Existing Heterophoria, Ophth. Rev. **32**: 65, 1913; cited by Wood, C. A.: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1916, vol. 8, p. 5892.

Trousseau, A.: Clinique médicale de l'Hotel-Dieu de Paris, ed. 3, Paris, J.-B. Baillière & fils, 1868, p. 205.

Tryde, cited by Ebstein.

Tsiekhanovich, A. Z.: Sluchaĭ herpes zoster facialis (zona ophthalmica), Voyenno-med. J. (med.-spec. pt.) **188**:869, 1897.

Tucker, J. I.: Case of Herpes Zoster Frontalis, J. Nerv. & Ment. Dis. **3**:561, 1876.

Turner, H. H.: Herpes Zoster Ophthalmicus Associated with Ophthalmoplegia Totalis, Pennsylvania M. J. **25**:495, 1921-1922.

Tyzzer, E. E.: The Histology of the Skin Lesions in Varicella, Philippine J. Sc. **1**:349, 1906.

Urrets Zavalía, A.: Hipertensión ocular primitiva coma manifestación inical del zona oftálmico, Prensa méd. argent. **10**:910, 1923-1924.

Hipertensión ocular en herpes zoster, Arch. de oftal. hispano-am. **26**:157, 1926.

Valière-Vialeix, V.: Fréquence de la kératite parenchymateuse dans le zona ophtalmique, Ann. d'ocul. **168**:341, 1931.

Lésions cornéennes du zona ophtalmique, Bull. Soc. d'opht. de Paris, 1932, p. 382.

Valude and Gallois: Typical Ophthalmic Zona with Double Ptosis, Bull. Soc. d'opht. de Paris, 1924, p. 207.

Van Lint, A.: Zona ophtalmique et zona maxillaire superieure, Bruxelles-med. **7**:636, 1927.

Vargha, P.: Facial Paralysis as Rare Complication, Orvosi gyak. Kerdes, 1938, p. 196.

Vasque, B. A.: Herpes Virus in Ocular Pathology, Oftalmologia **2**:16, 1937.

Vaughan, A. E.: Extensive Herpes Involving Mucous Membrane, Memoranda, Brit. M. J. **1**:203, 1897.

Vázquez Barrière, A.: Las complicaciones óculomotoras del zona oftálmico: Un caso de oftalmoplegia total, Arch. urug. de med., cir. y especialid. **3**:498, 1933.

Veasey, C. A.: Ophthalmic Zoster, Retrobulbar Neuritis, Acute Glaucoma, Am. J. Ophth. **2**:760, 1919.

Veil, P.: Neoformation du pole postericur de l'oeil droit; zona ophtalmique gauche, Bull. Soc. d'opht. de Paris, 1929, p. 264.

Velter, E.: Ophtalmoplegie total au cours d'un zona ophtalmique, Arch. d'opht. **43**:634, 1926.

Vendel, S. N.: Cure of Herpes Zoster by Pituitary Treatment, Ugesk. f. læger **85**:222, 1923.

Verco, J. C.: Trigeminal Herpes, Australasian M. Gaz. **11**:132, 1891-1892.

Verderame, F.: Sclero-cheratite e cyclite con aumento della tensione nel corso dello zona oftalmico, Ann. di ottal. **42**:772, 1913.

Verhoeff, F. H., in discussion on Veasey.

Verneuil, A.: De l'herpès traumatique, Gaz. méd. de Paris **2**:297, 312, 340 and 351, 1873.

Vernon, B. J.: Five Cases of Herpes Ophthalmicus, St. Barth. Hosp. Rep. **4**:121, 1868.

Vialeix, V.; Prosper-Veil, and Isnel, R.: Sur quelques complications envisagées habituellement comme rares dans le zona ophtalmique, Ann. d'ocul. **162**:569, 1925.

Viallefont, H.: Quatre cas de zona ophtalmique, Arch. Soc. d. sc. méd. et biol. de Montpellier **20**:452, 1939.

Vignal, W.: Traitements physiothérapeutiques du zona et de ses séquelles douloureuses, Paris méd. **1**:373, 1929.

Vincent, C.: Zona ophtalmique, Rev. neurol. **29**:548, 1922.

Vörner, H.: Ueber wiederauftretenden Herpes zoster, im besonderen über Zoster erythematosus und Zoster vegetans, München. med. Wchnschr. **51**:1734, 1904.

Vogel, F. E.: Augenmuskellähmungen bei Herpes zoster ophthalmicus, Inaug. Dissert., Leipzig, E. Lehmann, 1912.

Voight, in Wilbrand and Saenger.

Voisin, M. J.: Zona ophtalmique et ophtalmoplégie, Bull. Soc. d'opht. de Paris, 1936, p. 399; Ann. d'ocul. **173**:820, 1936.

Vorhaus, M. G.: Present Evaluation of Vitamin B_1 Therapy, Am. J. Digest. Dis. & Nutrition **3**:915, 1937.

Wadsworth, O. F.: Herpes Zoster Ophthalmicus Involving Whole Side of Nose Without Affection of the Eye, Boston M. & S. J. **92**:224, 1875; Tr. Am. Ophth. Soc. **2**:219, 1874.

Wagner, E.: Pathologisch-anatomische und klinische Beiträge zur Kenntnis der Gefässnerven, Arch. d. Heilk. **11**:305, 1870.

Wagner, R.: New Remedies in Ocular Therapy, Ceskoslov. oftal. **3**:5, 1937.

Walker, C. J.: Herpes Zoster Ophthalmicus, Am. J. Ophth. **21**:1041, 1938.

Walker, J. R., and Walker, B. F.: Specific Treatment for Herpes Zoster, Arch. Ophth. **20**:304 (Aug.) 1938.

Wallace, W. T.: Notes on a Case of Herpes Zoster Ophthalmicus, Ophth. Rec. **20**:119, 1911.

Wangler, J.: Der Herpes corneae, Inaug. Dissert., Zurich, Luzern, H. Keller, 1889.

Watt, J.: Herpes Zoster and Varicella, Lancet **1**:691, 1921.

Weber, F. P.: Herpes Zoster: Its Occasional Association with a Generalized Eruption and Its Connection with Muscular Paralysis, Internat. Clin. **3**:185, 1916.

Two Cases of Herpes Zoster Associated with a Generalized Eruption of Varicella-Like Spots, Brit. J. Dermat. **28**:13, 1916.

Weeks, J. E.: Glaucoma Resulting from Herpes Zoster Frontalis, Tr. Am. Ophth. Soc. **15**:134, 1917; Arch. Ophth. **46**:460, 1917.

Weidner: Drei Fälle von Zoster, Berl. klin. Wchnschr. **7**:321, 1870.

Weill, G., and Reys, L.: Zona ophtalmique et paralysie faciale d'origine syphilitique, Rev. d'oto-neuro-ocul. **3**:62, 1925.

Weill, N. J.: Herpes Zoster Ophthalmicus, Philadelphia M. J. **4**:943, 1899.

Weizel, R.: Beitrag zur Kenntnis des Herpes simplex und zoster, München. med. Wchnschr. **85**:396, 1938.

Wheelock, K. K.: Herpes Zoster Ophthalmicus, Fort Wayne J. M. Sc. **7**:173, 1887.

Wible, E. E.: Herpes Zoster Ophthalmicus, Pennsylvania M. J. **21**:120, 1917.

Wilbrand, H., and Saenger, A.: Die Neurologie des Auges, Munich, J. F. Bergmann, 1901, vol. 2, p. 176.

Williamson-Noble, F. A.: Affections of the Eye Due to Virus, Tr. Ophth. Soc. U. Kingdom **51**:16, 1931.

Wilson, A. D.: Herpes Zoster Ophthalmicus, Southwestern Med. **1**:31, 1917.

Wintzer, G.: Le traitement du zona par l'autohémothérapie, Thesis, Paris, no. 373, 1926.

Wohlwill, F.: Zur pathologischen Anatomie des Nervensystems beim Herpes zoster (auf Grund von 10 Sektionsfällen), Ztschr. f. d. ges. Neurol. u. Psychiat. **89**:171, 1924.

Wolff, E., in discussion on Neame (1931), p. 36.

Wood, C. A.: Herpes of Face and Cornea, Chicago M. Rec. **1**:15, 1891.

Wood, H.: Herpes Zoster Ophthalmicus Complicated by Persistent Neuritis, Am. J. Ophth. **12**:759, 1929.

Woods, H., in discussion on Veasey.

Worms, cited by Renard.

Worster-Drought, C.: Herpes Zoster with Localized Muscular Paralysis, Brit. M. J. **1**:970, 1923.

Würdemann, H. V.: Herpes Zoster Ophthalmicus, Am. J. Ophth. **3**:756, 1920.

Wyss, O.: Beitrag zur Kenntnis des Herpes zoster, Arch. f. Heilk., 1871, p. 261.

Yanes, T. R.: Contribucion al empleo de un nuevo metodo en la terapeutica del herpes zoster oftalmico, Rev. cubana de oftal. **1**:427, 1929.

Young, A. A.: Herpes Facialis, Tr. M. A. Central New York (1896), 1897, p. 74.

Zander-Olsson, B.: Case of Ophthalmic Zona and Chickenpox in Woman 78 Years Old, Nord. med. tidskr. **12**:2084, 1936.

Zangger, T.: Herpes zoster facialis seu ophthalmicus mit Hämaturie, Cor.-Bl. f. schweiz. Aerzte **28**:424, 1898.

Zeeman, W. P. C.: Ueber den heutigen Stand unserer Kenntnisse von den Herpeskrankheiten des Auges, Klin. Wchnschr. **4**:241, 1925.

Zentmayer, W.: A Case of Herpes Zoster Ophthalmicus Complicated by Oculomotor Palsy, Am. Med. **4**: 1007, 1902.

Zutt, J.: Einseitige reflektorische Pupillenstarre nach schwerem Herpes zoster im Gebiet des 1. und 2. Trigeminusastes (einschliesslich der Cornea), Monatschr. f. Psychiat. u. Neurol. **93**:305, 1936.

Abstracts from Current Literature

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Conjunctiva

A CASE OF PRIMARY CHANCRE OF THE BULBAR CONJUNCTIVA. C. DEE SHAPLAND, Brit. J. Ophth. **28:** 187 (April) 1944.

A man aged 20 complained of a discharge from the left eye of ten days' duration. There was edema of both lids, and the caruncle and plica semilunaris were unduly evident. The parotid and submaxillary glands were firm and discrete. On eversion of the lower lid a band of cartilaginous consistence, directly continuous with the lower end of the edematous plica and laterally becoming lost on the bulbar conjunctiva inferotemporally, came into view. On its surface there was a small, grayish white ulcer, with sloughing base. There was practically no discharge. A specimen of serum from the ulcer contained Treponema pallidum. Serologic tests of the blood gave weakly positive reactions for syphilis. There was a gradual, almost complete, disappearance of all symptoms under treatment with oxophenarsine hydrochloride (mapharsen) and a proprietary suspension of metallic bismuth.

The article is illustrated with a photographic plate in color.

W. ZENTMAYER.

VIRUS OPHTHALMIA NEONATORUM. A. SORSBY, E. E. HOFFA and E. N. YOUNG, Brit. J. Ophth. **28:** 451 (Sept.) 1944.

An account of the inclusion type of ophthalmia neonatorum is given. From a study of 27 cases observed in a series of 269 consecutive cases of ophthalmia neonatorum at White Oak Hospital it is concluded that, apart from a later onset in most, but by no means all, cases, inclusion blennorrhea has no features which distinguish it from microbial ophthalmia neonatorum, either in course or in response to sulfonamide therapy. In 5 of 25 mothers of infants with inclusion blennorrhea, cervical scrapings showed inclusion bodies.

The article is illustrated.

W. ZENTMAYER.

Cornea and Sclera

DESICCATION KERATITIS. J. E. M. AYOUB, Brit. J. Ophth. **28:**347 (July) 1944.

The article describes a corneal disorder which was first noticed among the troops of the Eighth Army fighting in the desert during the summer of 1942. A private communication from Capt. Martin Williamson, M.C., R.A.M.C., indicates that the condition was widespread and occurred especially in observation post officers, drivers and patrols—all key men.

The subjective symptoms included smarting and itching of one or both eyes, profuse lacrimation, severe photophobia and definite disturbance of vision, which consisted either of uniocular diplopia or of seeing dark objects as having a tail-like prolongation, like a comet, or as vaguely blurred.

Only the superficial epithelial layers of the cornea were affected. Three main types were noted: 1. The commonest lesion was a bandlike roughening of the corneal epithelium across the area which would be exposed when the eyes are partially closed, as is the case in a bright light. The band was grayish, but translucent, and stained with fluorescein, revealing the loss of epithelium. The appearance was punctate. 2. The lesion was sometimes limited to a few lines of grayish dots, mainly horizontal and in the exposed regions of the cornea. These dots also stained with fluorescein. 3. A single stippled line, actively staining, was also seen at times.

The fissural portion of the eyeball was congested. The following causative factors are discussed: (1) damage by light radiations of short wavelength, i. e., photophthalmia; (2) damage of the epithelium by driven sand, carried in a sandstorm or raised by vehicles driving in front or by shelling; (3) action of irritant gases; (4) drying of the exposed area of the cornea by intensely hot air or wind; (5) undue exposure of the affected area of the cornea due to fatigue, which reduces the frequency of the blinking reflex of the lids. This would predispose to the influence of factor 4. It is probable that the cause is drying of the corneal epithelium by a hot dry wind, which produces excessive evaporation of the lacrimal secretion over the exposed area of the cornea.

The suggestion is put forward that corneal damage ascribed to snow blindness is caused, certainly in part, by desiccation and perhaps also by freezing of the corneal epithelium, and not by excessive reflections of ultraviolet light.

W. ZENTMAYER.

A STUDY OF EIGHTY-FOUR CASES OF DELAYED MUSTARD GAS KERATITIS FITTED WITH CONTACT LENSES. I. MANN, Brit. J. Ophth. **28:** 441 (Sept.) 1944.

Mann gives the following summary: Eighty-four cases of delayed mustard gas keratitis are reviewed. All the patients were fitted with contact lenses, some of them seven years ago. Thirty-

nine of the patients wear their lenses from eight to sixteen hours a day; 11, from five to eight hours; 8, under five hours; 5, not at all, and for 21 the time is not known. The visual acuity of all but 2 patients was notably improved. In 25 cases there was no further relapse after fitting; in 4 cases there was one relapse only; in 16, slight relapses, and in 10 only were the relapses severe. The age of onset of the symptoms, the occupation of the patients and the treatment of intercurrent complications are discussed.

W. ZENTMAYER.

HERPES SIMPLEX CORNEAE IN MALARIA. J. GRAHAM SCOTT, Brit. M. J. **2:** 213 (Aug. 12) 1944.

In 4 cases of uniocular herpes simplex corneae among 4,000 cases of malignant tertian malaria corneal lesions occurred between the seventh and the sixteenth day of illness. The best result followed removal of the corneal epithelium with a strong iodine solution (7 per cent iodine and 5 per cent potassium iodide in alcoholic solution).

ARNOLD KNAPP.

TREATMENT OF CORNEAL DISEASES BY RIBOFLAVIN. S. BARRENECHEA, R. CONTARDO and J. ARENTSEN, Ophth. ibero-am. **4:** 405, 1943.

Barrenechea and his associates treated with riboflavin 109 patients presenting corneal ulcers and corneal vascularization of various causes. In 70 per cent of the patients the disappearance of ulcers and vascularizations was remarkably rapid. The average time for the complete healing of the ulcers was seventy hours. The vascularization disappeared in three days to two weeks. The treatment failed with 30 per cent of the patients, 15 per cent of whom were shown to have tuberculous ulcers, which flared up on the administration of riboflavin.

J. A. M. A. (W. ZENTMAYER)

General Diseases

REPORT ON TWO PAIRS OF BROTHERS SHOWING MARFAN'S SYNDROME. H. J. STERN, Brit. J. Ophth. **28:** 229 (May) 1944.

The oldest brother of the first pair was 14½ years of age, underweight and undeveloped; he showed hypogenitalism, an undescended right testicle and a small left testicle. There were frequent extrasystoles and prominent hypertrophied veins on the chest. The limbs and fingers were characteristic of the syndrome. There was incomplete embryotoxon. The pupils were irregular in shape, and there was iridodonesis. There were two small bridge colobomas of the iris. In its temporal lower part the iris showed a peculiar spongy structure, making the parenchyma partly float in the anterior chamber. Both lenses were luxated. The sella turcica was very small.

The younger brother was 12 years of age. He was undersized. Arachnodactyly was present. Both lenses were displaced.

The parents were healthy and normal. The sella turcica of the father was small.

The parents and other children of the second pair of brothers suffered with more or less severe obesity of endocrine origin. Several members of the family had high myopia.

The older brother was 14 years of age and was oversized but well developed. Arachnodactyly was present. There was habitual subluxation of the humerus and of the fingers. The sella turcica was small. There was subluxation of both lenses.

The younger brother was 11 years of age. He was oversized. He presented the same general anomalies as his brother. Both lenses were subluxated.

The author believes the 4 cases presented support the views expressed by Mann that the disturbances in Marfan's syndrome are probably only coordinated symptoms of a genotypic disturbance, producing general and ocular troubles which affect not only the mesoderm but the endocrine glands and the ectoderm.

W. ZENTMAYER.

Injuries

THE EYE DEPARTMENT IN A MIDDLE EAST GENERAL HOSPITAL. H. B. STALLARD, Brit. J. Ophth. **28:** 261 (June) 1944.

The author gives a brief survey of the organization and nature of the work of the department of ophthalmology in one of the hospitals serving in the Eighth Army from the autumn of 1940 to the conclusion of the North African campaign, in May 1943.

About 30 per cent of fragments from shells, hand grenades and land mines may be extracted by the posterior route. The figures for extraction of pieces from shells and land mines by the anterior route are less favorable.

Sixty-eight patients with retinal detachment were treated with surface diathermy and suction drainage of the interretinal fluid through diathermy penetration of the sclera and choroid. Three patients were treated for myopia, all successfully; 10, for cystic degenerations, all successfully; 20, for degeneration after healed choroidoretinitis, all successfully; 21, for contusions of civil type, with 18 successes, 2 immediate failures and 1 partial recurrence, and 18, for war trauma, with 14 successes and 4 partial recurrences.

W. ZENTMAYER.

BLIND BULLET INJURY TO THE EYE: REPORT OF A CASE. K. U. KAZANDASHEV, Vestnik oftal. **22:** 48, 1943.

A soldier was injured while lying on the ground shooting with his right eye open. There was chemosis of the conjunctiva, with pronounced exophthalmos and limitation of motion of the eyeball in all directions. A small entrance wound was present in the upper nasal quadrant of the conjunctiva; the iris was inflamed, and a number of hemorrhages were seen in the choroid and the retina. Vision was reduced to counting fingers. The roentgenogram showed a bullet in the orbit.

An incision was made in the brow; the orbital bone was removed, and the bullet was extracted from the muscle funnel. The inflammatory process in the eye became quiescent, and vision increased slightly.

The interesting feature of this case is that the bullet hit the eye directly but did not injure the eyeball or the orbital bones. The changes in the eye were of contusive character.

O. SITCHEVSKA.

Methods of Examination

PRINCIPLES OF RETINOSCOPY PRESENTED ON BASIS OF THEORY OF PROJECTION. M. KLEIN, Brit. J. Ophth. **28:** 157 (April) 1944.

The principles of retinoscopy are presented on the basis of the theory of projection. Klein gives the following summary:

The nature of the light pencil emitted by the patient's eye during retinoscopic examination is best understood on the basis of the projection theory.

Retinoscopy is an aperture test by means of which the point of reversal of a myopic eye, or of an eye made myopic by trial lenses, is determined.

The elements of the illumination and of the returning observation systems of retinoscopy are analyzed.

Certain factors need further consideration.

1. The retinoscopic field can be substituted by the mirror hole.

2. The speed of reflex movement is explained by the area of the cross section of the emitted light pencil at the plane of the retinoscopic mirror.

3. The brightness of the pupillary light depends on brightness of the light source, distance, apertures, loss in transmission and the vergence of the emitted light pencil.

4. The retinoscopic reflex seen in the pupil is influenced by the size of the original source of light and the mirror used.

5. The following factors influence the point of reversal: (*a*) Sudden change of light and shadow at the point of reversal. (*b*) The observer's retina receives during the retinoscopic test image elements of the patient's fundus or confusion circles of it, depending on the vergence of the emitted light pencil. The size of the confusion circles is maximum at the point of reversal. (*c*) The factors influencing the point of reversal set a limit to the accuracy of retinoscopy.

A number of diagrams illustrate the optical principles involved.

W. ZENTMAYER.

RETINOSCOPY IN ASTIGMATISM. M. KLEIN, Brit. J. Ophth. **28:** 205 (May) 1944.

Klein summarizes his results as follows:

"A table of the optical power of obliquely crossed cylinders, and the implications of oblique cylinder ideas for retinoscopy with cylinders are presented.

"The basis of streak-retinoscopy is a band-like retinal image of the immediate source of light, which can be rotated in the principal meridians of astigmatism.

"Similarities exist between cylinder-retinoscopy and streak-retinoscopy as regards ascertaining the axis and the amount of the required cylinder.

"A survey of different instruments of the streak retinoscope group, and their practical use is given."

W. ZENTMAYER.

Neurology

SIMPLE ATROPHY OF THE OPTIC DISK: A SIGN OF SUBTENTORIAL TUMOR. M. PUIG SOLANES, Gac. méd. de Mexico **73:** 199 (June-Aug.) 1943.

Puig Solanes directs attention to the diagnostic value of simple atrophy of the optic disk in cases of tumors of the fourth ventricle or of the cerebellum. Optic nerve atrophy in these cases is the result of the acute dilatation of the ventricular system. Because ventriculography is contraindicated in certain cases of cerebral tumor, the diagnostic value of simple atrophy of the optic disk is obvious. The presence of this change in patients with symptoms of intracranial hypertension and other signs of involvement of cerebral structures in the posterior cranial fossa is pathognomonic of a tumor in this area. The diagnostic value of simple atrophy of the optic disk in cases of the aforementioned conditions is so reliable that it renders ventriculographic examination unnecessary. The author reports 4 cases in which the diagnosis was verified by removal of the tumor from either the fourth ventricle or the cerebellum.

J. A. M. A. (W. ZENTMAYER)

Ocular Muscles

NORMS OF LATENT STRABISMUS IN SELECTION OF CANDIDATES FOR AVIATION SCHOOLS. S. M. KHAYUTIN, Vestnik oftal. **16:** 148, 1940.

This study was made in order to evaluate the relation between horizontal heterophoria for distance and other functions of the eye. Examinations were made mostly in the afternoon; determinations of visual acuity, refraction, visual fields, muscle balance, accommodation, and color sense were usually made and an ophthalmoscopic study done. The Maddox scale and Maddox rod with prisms were used for the measurement of muscle balance. Of 1,500 subjects examined, orthophoria was found in 38 per cent, esophoria in 32 per cent and exophoria in 30 per cent. The ages ranged from 20 to 22 years, and visual acuity was not less than 0.8; in other words, there were few cases of myopia or astigmatism. In some of the subjects examined repeatedly during a period of eight to ten months, orthophoria changed into exophoria or esophoria. Fever and emotional stress produce heterophoria of 3 to 4 degrees.

The relation between muscle balance and depth perception was studied in 112 candidates by the Howard-Dolman apparatus. Heterophoria for distance of about 4 degrees does not affect depth perception.

The author drew the following conclusions:

1. That part of heterophoria which has no direct relation to anatomic causes is unstable; its amplitude depends on the refraction, the tonus of the muscles and the general physical and emotional condition.

2. Muscular asthenopia is not directly the result of heterophoria and depends not only on the tonus of the muscles but on the general condition.

3. With heterophoria up to 4 degrees the depth of perception does not deviate from the normal.

4. In cases of variation in the degree of heterophoria the tests should be repeated in order to eliminate accidental factors.

O. SITCHEVSKA.

Operations

OPHTHALMIC SURGERY IN WARTIME. A. I. POKROWSKY, Vestnik oftal. **22:** 4, 1943.

Transplantation of Fat in Operations on the Lids.—Transplantation of fat in plastic operations on the lid is indicated (*a*) in cases of deep scars with adhesions to the bone, in which the skin is little traumatized and is not shortened too much; (*b*) in cases of scars of the bone with formation of fistula, and (*c*) in cases of transplantation of skin in which irregular relief of the skin develops and disfigures the face. The histories of 4 cases in which fat was taken from the patient's body and transplanted under the skin of the deep scar after injury to the lid and adjacent parts, so common in the present war, illustrate the good cosmetic results obtained in young persons with such injuries.

Transplantation of Fat in Operations on the Injured Orbit.—Transplantation of fat is indicated in cases of injury or tumor of the orbit, the walls of which are either destroyed or thinned. Depressions may form, with resultant disfigurement of the face. The procedure is also indicated in cases of deformity of the conjunctival sac. The transplantation of fat in the orbit took completely in all but 4 to 5 per cent of cases. The operation should be done after the inflammatory process has quieted down; the fat is taken from the abdomen or the buttocks.

War Injuries of the Lids; Early Plastic and Orthopedic Treatment of the Conjunctival Sac.—In injuries of the lids in wartime, Pokrowsky recommends the immediate use of sutures, which will avert the necessity of complicated plastic operations in the future. He believes that there may be local immunity to various micro-organisms, as infection is rarely encountered in suturing the lid despite the presence of a number of bacteria.

In injuries of the eyeball, including the lids and conjunctiva, Pokrowsky advises that necessary surgical procedures on the conjunctival sac be done immediately after the enucleation, as the conjunctiva does not easily become infected and does not shrink much. In order to enlarge the conjunctival sac, a deep incision of the conjunctiva is made parallel to the margin of the lid; a prosthesis is used systematically after cod liver ointment is applied, and thus the conjunctival sac retains its normal size. The author illustrates the case histories. He stresses that each case be individualized in order to restore the normal relation of the tissues.

O. SITCHEVSKA.

Orbit, Eyeball and Accessory Sinuses

INCOMPLETE AVULSION OF THE EYE: REPORT OF A CASE. I. C. MICHAELSON, Brit. J. Ophth. **28:** 458 (Sept.) 1944.

The patient was a man aged 29 years. An attempt had been made to gouge out the right eye with a spike ring the day before. There was a cleancut oval incision wound through the upper and lower lids, including the conjunctiva, which separated them from the orbit through most of their extent and caused them to flap outward on a temporal base. The globe was extremely proptosed and could not be replaced. All four rectus muscles were completely severed from their global attachments. The vitreous showed an extensive hemorrhage. Visual acuity was limited to perception of hand movements. The rectus muscles were sought for in the orbit and stitched to their insertions. The lids and conjunctiva were brought back into position. An uneventful recovery occurred. The patient was reexamined

about sixteen months later. The eye was somewhat divergent, with some limitation of adduction; otherwise the ocular movements were good. There was pronounced optic nerve atrophy. Visual acuity was 6/9, and the visual field was concentrically contracted, with a small paracentral scotoma. It is assumed that either there had been stretching and tearing of the optic nerve fibers, with an escape of those serving the central field, or the orbital hemorrhage had compressed the peripheral fibers of the nerve proximal to the level at which the macular fibers leave the periphery of the nerve to course in its central position.

The article is illustrated. W. ZENTMAYER.

MALIGNANT EXOPHTHALMOS. P. SUNDER-PLASSMANN, Zentralbl. f. Chir. **69:** 88 (Jan. 17) 1942.

According to Sunder-Plassmann, there are cases of exophthalmic goiter in which the exophthalmos continues to increase after removal of the thyroid. These are cases of malignant exophthalmos. In the mild form of malignant exophthalmos conjunctival excision has been effective, but there are also cases in which the exophthalmos increases to a point of perforation of the eye. The author reports a case in which enucleation of the eyes became necessary. In another case conservative measures proved ineffective. Both eyes had advanced corneal ulcers, and spontaneous perforation seemed imminent. The patient required morphine for control of the pain. The visual capacity was practically nil. As a last resort, it was decided to attempt the operation described by Naffziger in 1933, which that author had successfully employed in 6 cases. Bilateral trepanation was done, and then by the intracranial approach complete decompression of the orbit was effected, as well as decompression of the roof of the nerve canal. As had been observed by Naffziger, the ocular muscles were enormously enlarged, and both optic nerves showed extreme edema. The patient tolerated the operation well. The exophthalmos receded rapidly, and complete closure of the eyes became again possible. The corneal ulcers healed. The patient regained normal visual capacity, and her general condition is excellent.

J. A. M. A. (W. ZENTMAYER)

Retina and Optic Nerve

A CASE OF ANGEOID STREAKS OF THE RETINA. T. H. BUTLER, Brit. J. Ophth. **28:** 220 (May) 1944.

The chief interest in the case reported by Butler is that he was able to examine the fundi before there was any ophthalmoscopic evidence of abnormality, and that somewhat rapid changes were observed subsequently. At the time of the first examination the patient complained of metamorphopsia. Vision in the left eye could not be improved and was about 6/12 mostly. Both fundi appeared normal. In about a fortnight vision had failed in the right eye to 6/36 and in the left eye to 6/24. About six months later vision was further reduced, especially in the right eye, in which it equaled less than 6/60. In the right eye there was a large soft exudate rising from the surface of the retina at the macula, which later became white and harder in appearance. In the left eye the macula was normal. The white masses about the disk were noted about three weeks later. The angioid streaks were characteristic, and there was diffuse "pepper and salt" choroiditis.

A few months later the streaks were less apparent, especially in the left eye. Vision in the right eye was reduced to counting fingers at 1 meter, and in the left eye it was 6/6 with correction. The right field showed a central scotoma about 5 degrees in extent. Butler thinks the case supports Law's conclusions that the streaks are probably caused by folds of the retina with a deposit of pigmentary debris between the rods and cones and the pigment layer.

The article is illustrated.

W. ZENTMAYER.

Trachoma

STUDY OF TRACHOMA WITH REPORT OF 318 CASES, 233 TREATED WITH SULFANILAMIDE. C. GALLAHER, J. Oklahoma M. A. **36:** 185 (May) 1943.

Gallaher submits a statistical analysis of 318 cases of trachoma; most of these patients were treated by him during the last four years. One hundred and eighty-eight of the patients were males and 130 were females; 209 were white; 108 were Indians, and 1 was a Negro. Trachoma is rare among the Negro population. All but 3 of the patients received ambulatory treatment. The adults numbered 134; the children, 184. The author abandoned the use of copper sulfate sticks because of the pain associated with their use. If a treatment is too painful, the patients refuse to return. Silver nitrate was used only in cases in which a complicating gonorrheal infection was present. It was not usually repeated. One or more of the following therapeutic methods were used with all cases: sulfanilamide by mouth, in 199 cases; grattage, in 26 cases; brossage, in 2 cases; zinc sulfate, in 58 cases; copper sulfate solution, in 46 cases; sulfanilamide (1 per cent in isotonic solution of three chlorides), in 40 cases; sulfathiazole, in 3 per cent concentration in ointment, in 9 cases, and vitamin A (25,000 U. S. P. units or more daily), in 4 cases. The results of sulfanilamide therapy were such that the drug must

be included in the treatment of trachoma. No treatment with or without sulfanilamide produces beneficial changes in every case. Well over 90 per cent of patients can be assured of some improvement. Sulfanilamide therapy, in combination with other drugs, affords a method which may be used with reasonable safety without hospitalization and without the necessity of prolonged daily treatment and observation. One or more courses of sulfanilamide therapy alone are apt to produce disappointing results. The specific remedy for trachoma is not yet found. The essential nature of the disease, its cause and its treatment remain a problem to be solved.

J. A. M. A. (W. ZENTMAYER)

Tumors

RETRO-ORBITAL ADRENAL REST TUMOR. L. W. HUGHES and A. AMBROSE, J. A. M. A. **126:** 231 (Sept. 23) 1944.

Hughes and Ambrose removed a tumor, more or less olive shaped, from the orbit of a woman aged 21. The growth was situated behind and slightly above the globe and seemed firmly fixed.

Dr. H. S. Martland reported that the tumor was well encapsulated and appeared to be benign. It was composed chiefly of cells which appeared like hepatic cells or cells from the adrenal cortex, arranged in a manner similar to that of the zona fasciculata of the adrenal cortex, with occasional lumen formation. There were many areas of small round cells. Martland was "inclined to interpret the tumor as a congenital fault somewhat in the nature of an adrenal rest (which has been described in the region of the head) and . . . to regard the collection of small round cells as probably of neurogenic origin."

The article is illustrated.

W. ZENTMAYER.

REPORT OF A CASE OF PRIMARY CARCINOMA OF LACRIMAL SAC. J. R. WHEELER, Brit. J. Ophth. **28:** 233 (April) 1944.

A man aged 49 had a tender swelling over the lacrimal sac with a granular mass in the region of the right middle turbinate. A biopsy of this mass revealed no tumor cells. A dacryocystectomy with complete removal of the tumor mass was performed and radium applied. The tumor had arisen from basal cells of the epithelium and histologically had some resemblance to an oat cell carcinoma of the lung. The subepithelial connective tissue of the turbinate was invaded by tumor cells similar to those of the tumor of the lacrimal sac.

W. ZENTMAYER.

Therapeutics

LOCAL CHEMOTHERAPY IN EXPERIMENTAL LESIONS OF THE EYE PRODUCED BY STAPH. AUREUS. J. M. ROBSON and G. I. SCOTT, Lancet **1:** 100 (Jan. 23) 1943.

A highly virulent coagulase-positive strain of Staphylococcus aureus was used for infection of the rabbit cornea. A twenty-four hour broth culture in a dilution containing 1,500 organisms per cubic centimeter was injected intracorneally. The lesions produced were similar in the eyes of the same rabbit even after twenty-four hours. At this time, however, great variations were evident in the development of the lesion in different animals. Treatment was applied one hour after injection and consisted of hourly instillations of the chemotherapeutic agent for forty-eight hours, followed by hourly instillations during the day until the lesion was healed.

Sodium penicillin was compared with sodium sulfacetimide in 30 per cent and lower concentrations, solubilized sulfathiazole in 15 per cent solution and tyrothricin in a concentration of 1 milligram per cubic centimeter (tyrothricin consists of 15 per cent gramicidin and 85 per cent tyrocidin). One eye of the experimental animal was treated and the other used as a control. Penicillin was more effective than the other compounds, leaving slight residual scars, whereas in the control eyes lesions classified as moderately severe or severe developed. Sodium sulfacetimide was also definitely beneficial, but less so than penicillin. Ten and 30 per cent solutions of sulfacetimide were equally effective. In 2.5 per cent solution the drug did not exert any definitely beneficial effect. The results of the treatment with solubilized sulfathiazole and with tyrothricin were disappointing. When therapy was initiated twenty-four hours after the infection, no significant benefit was obtained with any type of treatment.

Instillations of penicillin rendered the conjunctiva free of Staph. aureus, in contrast to the treatment with 10 per cent sodium sulfacetimide, which did not influence the flora noticeably. Early and continued treatment with penicillin or sulfacetimide is required for the best results.

L. VON SALLMANN.

Society Transactions

EDITED BY DR. W. L. BENEDICT

AMERICAN OPHTHALMOLOGICAL SOCIETY

JOHN GREEN, M.D., *President*

WALTER ATKINSON, M.D., *Secretary*

Eightieth Annual Meeting, Hot Springs, Va., May 29-31, 1944

Evaluation of the Visual Acuity Symbols. DR. WALTER H. FINK, Minneapolis.

The presentation is a critical survey of the visual acuity symbols which are being used today. These symbols cannot be considered accurate from a scientific standpoint and are comparable to yardsticks of variable length.

A new symbol is presented which fulfils more of the requirements of the perfect symbol as suggested by Landolt.

DISCUSSION

DR. LE GRAND H. HARDY, New York: The author has done a splendid piece of work in making comparative tests; but I do not believe many ophthalmologists will be influenced to change their testing symbols because the test itself is a highly artificial laboratory experiment, which, unless correlated directly with the problems of occupation, experience, duties, etc., may assume an incommensurate importance.

The inaccuracy of the symbol is only one of many factors involved in testing visual acuity. I should not concede that the symbol used is the most important factor in the test.

Dr. Fink offers some helpful suggestions aimed at a compromise between "interesting" and "accurate" test symbols, but this problem is far from being solved, as is true also of the problem of avoiding fatigue and reducing the effects of memorization and guessing.

DR. S. JUDD BEACH, Portland, Maine: One cannot be told too often that charts that are suitable for refraction are unsuited for estimating visual acuity. The alphabet is a notoriously unreliable vision test. Therefore I think the broken ring, with three or multiple breaks, is likely to be useful. Furthermore, the *E* varies in distinctness according to the axis of the cylinder. A patient requiring a high vertical cylinder may recognize an *E* several sizes smaller than when the axis of the cylinder is oblique.

Removal of the Ruptured Capsule After Operations for Cataract. DR. F. H. VERHOEFF, Boston.

This paper was published in full in the November 1944 issue of the ARCHIVES, page 407.

DISCUSSION

DR. JOHN W. BURKE, Washington, D. C.: I want to show a capsule forceps which has been called the Lambert forceps, though that is not its correct name. This pair was made by Tieman and has the advantage of opening vertically, rather than horizontally.

DR. ARNOLD KNAPP, New York: I think this topic is a timely one, and, personally, I am glad to hear that some one else has had capsules rupture. I have always maintained, and have proved it to my own satisfaction, that if one uses the traction method of intracapsular extraction until after the subluxation of the lens, and then releases the grasp of the capsule forceps and expresses the cataract by use of the loop and the hook, fewer capsules are ruptured. Ruptures of the capsule occur under three conditions: First, at the start, when the capsule is grasped, particularly when the capsule is thin and tense. The condition is then the same as in an extracapsular cataract extraction. Second, in the middle of the procedure, generally owing to an awkward movement on the part of the operator or of the patient. With the rupture of the capsule there is frequently a rupture of the hyaloid membrane, with prolapse of vitreous. Third, after extraction of the cataract. It has been my experience that it is not difficult to grasp the capsule with the blunt forceps without complications if the illumination is good and, particularly, if one waits a few minutes to allow regeneration of the aqueous. It is of the greatest importance that no capsular tags remain in the incision.

DR. F. H. VERHOEFF, Boston: I am surprised that Dr. Knapp brings up the question of the relative frequency of rupture of the capsule with different methods of intracapsular extraction. He has admitted that he succeeds in removing the cataract intact in only 50 per cent of his cases. For my method, this would be a disgraceful record. In reporting several hundred cataract operations, he included only those in which the cataract was removed with its capsule. He said nothing as to the results in the equal number of his cases in which the capsule was ruptured during attempted intracapsular extraction. If these

results were not considerably inferior to the others, it would seem that the intracapsular operation should be abandoned. In answer to a question from another discusser: I think that fluorescent illumination would aid in the finding of a ruptured capsule, but in the procedure described I have found it unnecessary.

Complicated Cataract Associated with Spontaneous Detachment of the Retina. Dr. Bernard Samuels, New York.

This paper was published in full in the November 1944 issue of the Archives, page 416.

DISCUSSION

Dr. Arnold Knapp, New York: Now that all patients with retinal detachment are examined much more carefully, I am sure all have been impressed, as I have, with the frequency of an opacity at the posterior pole of the lens in cases of retinal detachment. I should like to ask Dr. Samuels whether this opacity is due to the presence of the vesicular cells which he has demonstrated in his slides.

Dr. Bernard Samuels, New York: In regard to the nuclear sclerosis, these eyes were mostly those of patients of mature years, so that it was thought the detachment had little, or nothing, to do with the condition of the nucleus.

I am unable to answer the question as to the permeability of the lens capsule.

In answer to Dr. Knapp's question, I have no doubt that the liquefaction of the cortical substance and the formation of vesicular cells at the posterior pole may at times account for the opacity seen there clinically.

Congenital Glaucoma and Bilateral Cataract Treated with Goniotomy and Needling: Report of a Case. Dr. Thomas D. Allen, Chicago.

An infant, seen at the age of 4 months, had low grade, but typical congenital glaucoma (hydrophthalmos), with enlarged, slightly hazy corneas, fairly deep anterior chambers, apparently normal irises and congenital cataracts. The tension of each eye was reduced with repeated goniotomies. When the anterior segments returned to normal, the pupils were dilated, without increase in tension, and the lenses were needled successfully.

DISCUSSION

Dr. Peter C. Kronfeld, Chicago: I am grateful to Dr. Allen for the opportunity of examining and following closely his interesting patient, whose left eye undoubtedly was hydrophthalmic. While spontaneous remissions do occur in cases of congenital glaucoma, it seems reasonable to assume that in the eye under discussion the normalization of the intraocular pressure and the clearing of the cornea are to be credited to one or several of the surgical procedures performed by Dr. Allen.

As a criterion of the success of his treatment he mentions that atropine could be used freely. There I beg to differ. Atropine has not been shown to cause appreciable increases in intraocular pressure in hydrophthalmic eyes.

The question arises whether the gonioscopic findings permit any statement with regard to which operation caused the normalization of the intraocular pressure. As far as I could see, little embryonic tissue was lying on the trabecula, and no furrow or groove was present in any of its visible portions. The anterior wall of the angle had apparently been incised in several places, but these incisions had healed over or were covered with peripheral anterior synechias. One clearly visible incision lay anterior to the line of Schwalbe. In the lower temporal quadrant a shallow cyclodialysis area seemed to be present. The case might be summed up by saying that the intraocular pressure in a hydrophthalmic eye was normalized probably by a cyclodialysis performed by the devious route through the anterior chamber.

Dr. Everett L. Goar, Houston, Texas: Not every one is equipped to do goniotomies, and some do not believe in them much, perhaps from lack of experience. However, there is an operation which any one who can hold a keratome can do safely—that is, an iridencleisis through a scratch incision, as advocated by Elschnig for his "iridectomia ab externa." I have performed this operation on 5 hydrophthalmic eyes and have been able to follow some of the patients for four years or more. They have all done well. It is important to treat such children early, before there is too much infiltration of the cornea or permanent damage to other structures.

Dr. Thomas D. Allen, Chicago: I wish to thank Dr. Kronfeld for discussing this paper. I do not quite hold with Dr. Barkan that one should always open Schlemm's canal. I have, on several occasions, obtained a definite internal cyclodialysis as a result of the goniotomy, and in one of the eyes reported on in this paper there may be an internal cyclodialysis. Although I perform a cyclodialysis when I believe it necessary, I am a little loath to do it because of the hemorrhage that often follows; a massive hemorrhage in the anterior chamber may be dangerous. Hemorrhage did not occur as a result of any of the operations on this baby. The advantage of this operation is that the cornea becomes smaller and clearer, the tension drops and remains low, the pupils remain central and round and the media are clear, so that a good view of the fundus is easily obtained.

I wish also to thank Dr. Goar for his discussion. I have not given up iridotasis in cases of congenital glaucoma; but I feel that if one can obtain good results without distorting the pupil, an advance in the operative technic has been made.

Glaucoma Due to Peripheral Anterior Synechias After Operation for Cataract. Dr. Peter C. Kronfeld and Dr. Joseph S. Haas (by invitation), Chicago.

This paper was published in full in the March 1945 issue of the Archives, page 199.

DISCUSSION

Dr. Lawrence T. Post, St. Louis: Dr. Kronfeld sent me a résumé of his paper before this meeting. I cannot discuss any phase of the subject of his thesis from other than a theoretic standpoint because I was unable to repeat any of the procedures. But for my own satisfaction, and as somewhat pertinent to the discussion, I reviewed 20 cases of glaucoma following cataract extraction from my own records and those of the eye clinic of Washington University. The data in these cases, admittedly too few to be more than suggestive, are tabulated to illustrate the relationship of delayed closure of the anterior chamber to other causes of this type of glaucoma. I also was interested in a comparison of McLean sutures and conjunctival sutures in preventing delayed closure of the anterior chamber.

Probable Cause	
Delayed reformation of anterior chamber (i. e., longer than 3 days)	11
Hemorrhage into anterior chamber	3
Unexplained cause	3
Postoperative iridocyclitis	1
Capsule in wound	1
Epithelization of anterior chamber	1

Closure of the anterior chamber was delayed in 3 of 6 cases in which McLean sutures were used, or in 50 per cent.

Closure was delayed in 8 of 14 cases in which conjunctival sutures only were used, or in 57 per cent.

These results suggest that closure by the former method is more effective, but the series is too small to show more than a trend. Possibly, also, there were errors of technic in using the McLean sutures.

The occurrence of hemorrhage into the anterior chamber in 6 of 20 cases is interesting, as is the fact that 4 of the 20 eyes were from 3 diabetic patients.

Dr. Jonas Friedenwald, Baltimore: I should like to add one suggestion to the speculation as to the mechanism concerned in the morning rise of pressure in these cases. Dr. Kronfeld has shown that the pressure rises during activity. Some time ago, Dr. Buschke and I showed that the secretory mechanism is under adrenergic control. It is possible, therefore, that the secretory activity might be less during sleep than in waking hours, owing to the difference in the activity of the adrenal glands. With pentobarbital the activity of the adrenal gland is greatly reduced. This assumption might be put to experimental test, and this is my reason for making these comments, by giving the patient an injection of epinephrine sufficient to produce a slight adrenalinemia during the period of the low pressure. One would expect that this would produce a rise of pressure. On the other hand, ergotamine antagonizes mainly adrenergic actions. Parenteral administration of ergotamine might temporarily prevent the rise of pressure in these cases.

Dr. Peter C. Kronfeld, Chicago: Tentatively, Dr. Haas and I have drawn the conclusion from our findings that in the normal human eye the rate of fluid production is greater during waking hours than during sleep. Such a physiologic increase in fluid production would explain the morning rises in intraocular pressure observed in our patients. We are grateful to Dr. Post for his discussion and shall follow the suggestions made by Dr. Friedenwald.

Deep Chamber Glaucoma Due to Formation of a Cuticular Product in the Filtration Angle. Dr. Algernon B. Reese, New York.

The endothelium on the posterior surface of the cornea produces a cuticular product (Descemet's membrane). The same endothelium continued into the filtration angle can likewise lay down this cuticular product under provocation. When this takes place along the internal surface of the pectinate ligament and in the interstices of the trabeculae, it can produce a deep chamber glaucoma. The changes of the endothelium are similar to those seen in cases of dystrophia epithelialis corneae. In the presence of the glaucoma, the corneal changes may be confused with bullous keratitis or pannus. Cases of deep chamber glaucoma of this type were described and analyzed, and various stages of the pathologic process were illustrated.

DISCUSSION

Dr. Peter C. Kronfeld, Chicago: The pathologic picture of partial or complete lining of the anterior chamber with a cuticular membrane is a fairly common finding in eyes with glaucoma following trauma, endogenous uveitis or retinal detachment. I had always considered these membranes as late pathologic changes, not related to the original pressure-elevating mechanism. Dr. Reese now presents the thesis that obstruction of the corneoscleral trabecula by the deposition of hyaloid material on its inner surface and in its interspaces is the direct cause of certain glaucomas. To me it seems that Dr. Reese has come as close to having proved his thesis as it is possible at this time. His material consisted of eyes that were removed because of intractable pain, which was most likely caused by recurrent corneal bullae or ulcers. It is to be hoped that the missing link in his chain of evidence will be provided when an early state of this type of glaucoma becomes

available for pathologic examination through the accidental or coincidental death of its bearer. Until then, one might look for traces of these cuticular membranes on the pieces of iris excised during trephine operations. Gonioscopy cannot be expected to throw any light on the subject.

From the study of Dr. Reese's paper it appears highly probable that he is describing a group of glaucomas characterized not only by similar pathologic changes but by a similar clinical course. In all but 2 of his cases corneal changes were in the foreground at an early stage of the glaucoma. Dr. Reese could have brought out this point more strongly had he mentioned the amount of vision present at the time of enucleation. If at that time the projection of light was still good in most of his cases, the glaucomatous process could not have been far advanced. To me it seems probable that Dr. Reese has described here a definite pathogenic entity among the glaucomas.

Dr. Reese attributes the failure of trephine operations in 4 of his cases to the growth of endothelium into the trephine opening and to the laying down of a cuticular product which partially fills the trephine opening and prevents filtration. Here I beg to differ. The openings made in successful trephine operations become lined with endothelium, which may lay down hyaloid material to a greater or lesser extent. I doubt that a complete cuticular lining of a trephine hole could by itself close off the opening, with the intraocular pressure acting on it. I believe it takes tissues with greater strength and resistance to oppose and block the filtration of intraocular fluid through a trephine hole.

DR. F. H. VERHOEFF, Boston: Dr. Reese's interpretation of his cases is so satisfying that I hope it will not be disproved. However, thirty-two years ago, I reported a few cases that may seem to throw some doubt on it, and since then I have seen many similar cases. I brought forward evidence I still believe to be valid, that sclerosis of the pectinate ligament sometimes results from a peripheral anterior synechia that later becomes freed. The evidence consisted chiefly in the fact that in places I found the iris still in the act of pulling away from the ligament. In some sections of one of the 10 eyes described, I found the exact condition now described by Dr. Reese; but, on making sections in other quadrants of this eye, I found places where the ligament was coated with connective tissue instead of elastic membrane, and other places where part of the ligament was covered with elastic membrane and the remainder with adherent iris. More important still, I found that nowhere did elastic membrane extend between the adherent iris and the ligament. On the contrary, it extended around the false angle for a short distance over the free surface of the iris. It was evident, therefore, that here the new membrane had been formed after the occurrence of a peripheral anterior synechia, and hence was probably a result, not the cause, of the glaucoma.

Errors in Diagnosis in Cases of Intraocular Tumor (Suspected or Real). DR. WILLIAM EVANS BRUNER, Cleveland.

Lessons from failures in diagnosis, either the errors of my colleagues and myself or those of others, may be obtained from the following cases:

CASE 1.—A man aged 58 had a condition previously diagnosed as detachment of the retina. Our diagnosis was intraocular tumor. On enucleation a spindle cell sarcoma was found.

CASE 2.—A man aged 55 had a condition diagnosed as probable serous detachment of the retina. Operation by his own oculist resulted in temporary improvement. Redetachment and, later, glaucoma necessitated enucleation, with the finding of melanotic sarcoma.

CASE 3.—A woman aged 42 had been previously treated for carcinoma of the cervix. She had a retinal detachment with shadow. The diagnosis was probable carcinoma. She was sent back to the original clinic. The oculist thought the condition was serous detachment and operated for this. The subsequent history is not known.

CASE 4.—A woman aged 55 had retinal detachment with shadow; there was no tear or hole. The diagnosis was probable intraocular tumor. An oculist in another city pronounced the condition serous detachment and performed operation. Four years later there was no evidence of tumor.

CASE 5.—A man aged 27 had a condition which we diagnosed as intraocular tumor. Operations by other oculists were performed. The sclera was punctured, and, later, trephination done. Four years later enucleation revealed a tumor.

CASE 6.—A girl aged 18 years had detachment with shadow and increased tension. She gave a history of a fall. Our diagnosis was probable subretinal hemorrhage, and she was treated for this condition. Another oculist made the diagnosis of tumor and removed the eye. The pathologic report was subretinal blood clot with glaucoma. There was no tumor.

DISCUSSION

DR. A. D. RUEDEMANN, Cleveland: The excellent, thought-producing report of Dr. Bruner's makes all realize that the diagnosis of intraocular tumor is not always difficult, but that the underlying causes require skill and study to determine. More than one visit to the office may be needed before a definite conclusion can be reached, or a stay in the hospital, with retrobulbar transillumination, may be required.

DR. F. H. VERHOEFF, Boston: Theoretically, there should be cases of intraocular tumor in which the separated retina shows a hole or is definitely tremulous, but I have never seen one. Has Dr. Bruner ever seen a hole in the retina in a case of intraocular tumor?

DR. WILLIAM EVANS BRUNER, Cleveland: I wish to thank those who discussed my paper.

I was interested to hear Dr. Verhoeff say that he had never seen a case of intraocular tumor with a hole or tear in the retina. This has also been my own experience, but, as previously stated, I do not understand why it should be so.

Bilateral Metastatic Carcinoma of the Choroid, with Roentgen Ray Therapy of One Eye. Dr. Frederick C. Cordes, San Francisco.

A case of bilateral metastatic carcinoma of the choroid secondary to a tumor of the breast in a woman aged 31 years was reported. One eye was enucleated, and the diagnosis of metastatic carcinoma was confirmed by microscopic examination. With the appearance of a similar growth in the second eye, roentgen irradiation was employed. This was followed by disappearance of the tumor and retention of 20/20 vision in the eye.

Fourteen months later there was a recurrence, and the tumor again responded to irradiation. With this method it was possible for the patient to retain 20/20 vision up to the time of her death (twenty-three months after enucleation).

While the ultimate prognosis is hopeless, the possibility of retaining useful vision by means of palliative treatment should receive consideration in cases of metastatic carcinoma of the choroid.

DISCUSSION

Dr. A. N. Lemoine, Kansas City, Mo.: I should like to report further on the case of bilateral carcinoma of the choroid which I reported in 1943, in the discussion of Dr. Ellett's paper at the meeting of the American Ophthalmological Society (Metastasis of Malignant Tumors to the Eye: Report of Two Cases, Arch. Ophth. **32:** 145 [Aug.] 1944). The patient died just a year after roentgen ray therapy of both eyes was instituted.

At the time the therapy was begun the patient had 10/200 vision in the right eye and 20/200 in the left eye, and the treatments produced complete recession of the growth in the left eye, with great reduction in the size of the lesion in the right eye. In October vision was 20/100 in the right eye and 20/30 + in the left eye; she retained useful reading vision in the left eye until the time of her death.

I strongly recommend the treatment as a therapeutic measure that will greatly add to the happiness of the last days of these unfortunate patients.

Spontaneous Retinal Reattachment. Dr. Arnold Knapp, New York.

This paper was published in full in the November issue of the Archives, page 403.

DISCUSSION

Dr. H. S. Gradle, Chicago: Is it not probable that Dr. Knapp has failed to differentiate between spontaneous reattachment of the retina and self-limited detachment? The two conditions are different. Spontaneous reattachment occurs in a small number of cases and leaves no aftermath except for the occasional presence of white retinal striae. On the other hand, self-limited detachment corresponds to the photographs shown by Dr. Knapp and has the following characteristics: (1) a pigmented line of demarcation; (2) detachment of the retina peripheral to this line of demarcation, persisting for many years; (3) preservation of vision according to whether or not the macula is involved, and (4) history of trauma.

Histologically, it has been shown that the white retinal striae lie within the retina proper and represent the organization of coagulated fibrin (*Fibringerinnseln*). The lines of demarcation, however, represent an organized exudation between the retina and the choroid and are always pigmented.

Dr. Arnold Knapp, New York: I did not read all of my paper; in it is a full description, with references from the literature which cover many of the things that Dr. Gradle was good enough to point out. I did not get the impression that these white wavy lines were in the retina. According to the histologic examinations which have been made, they were organized changes in the subretinal tissue. Shallow detachments do not occur in many cases, but sometimes there is a limited area of detachment directly around the hole. I think the presence of the limiting boundary has not been sufficiently noted, and when that is present it can be taken for granted that the detaching process has stopped.

Red-Free and Binocular Ophthalmoscopy. Dr. Ralph I. Lloyd, Brooklyn.

The results of using these instruments in examinations of the fundus over a number of years were summarized. Each makes a limited but valuable contribution to diagnosis of certain diseases of the fundus.

DISCUSSION

Dr. Jonas Friedenwald, Baltimore: Dr. Lloyd has restated part of the arguments of Vogt and Gullstrand, which constitute one of the classics in the literature of ophthalmoscopy. The work of these two great founders of modern ophthalmoscopy has never been adequately reviewed, and I shall not attempt to do so in the brief time allotted for the discussion of Dr. Lloyd's paper.

Vogt's choice of the red-free light filter arose from his effort to make visible in vivo the yellow color of the macula seen post mortem. With this light a yellow tinge is readily visible in the macular region, but Gullstrand denied, with many arguments, that this indicates the presence in vivo of a yellow pigment. The argument as to the existence of this yellow pigment was, however, soon refuted by the accidental discovery that more detail was visible in the eyeground illumi-

nated with red-free than with white light. Vogt attributed this increased detail to increased contrast in the ophthalmoscopic picture. It can easily be shown, however, that, in addition to the increased contrast, there is an increased resolving power in the optical system; i. e., finer details are visible. The source of this increased resolving power was found to be the decrease in the chromatic aberration of the optical system which occurs when part of the spectrum is eliminated from the illuminating system. Since this is true, it is possible to increase the resolving power still further by using light that is more nearly monochromatic. Just what portion of the spectrum should be chosen for the monochromatic illumination depends on what one is looking for.

DR. F. H. VERHOEFF, Boston: More than forty years ago I discovered that when after fixation in a solution of formaldehyde the macula was yellow in an enucleated eye, the sections showed ganglion cells in the macula and that when the macula was not yellow sections showed no ganglion cells there. I concluded, therefore, that the yellow color resided in the ganglion cells and was probably due to their lipid content. Ever since then I have given this explanation to my students. I have never searched the literature to ascertain whether any one before or since has given this explanation or proved it to be incorrect. Perhaps Dr. Lloyd, from his extensive study of the literature, can enlighten us on this matter.

DR. RALPH I. LLOYD, Brooklyn: I have nothing whatever on which to base an opinion as to the location of the pigment seen in the normal retina immediately after removal from the eye.

Analysis of Cases of Aniseikonia. DR. BEULAH CUSHMAN, Chicago.

This paper was published in full in the January 1945 issue of the ARCHIVES, page 9.

DISCUSSION

DR. L. T. POST, St. Louis: My associates and I have been making these tests at Washington University, in St. Louis, for ten years. It seems obvious that whereas aniseikonia is present in a great many people it causes symptoms in a relatively small number. The question whether one can say that the patient is relieved by aniseikonic correction or not is not entirely simple. I reported 100 cases four or five years ago, drawn at random from the files of patients who had worn their correction over nine months; 79 per cent had been improved, and 49 per cent, completely relieved. We have had about 1,200 patients for whom eikonic corrections have been ordered. Of these, I have examined about 450. From the records of 100 of these patients I found that 75 were given no change in their fundamental glasses of as much as 0.5 D. in the spherical or astigmatic correction. I did not, however, take into account small changes of axis. Of the remaining 25, 22 had a change between 0.5 and 1 D.; 3 had more than 1 D. We thought it wise to make such changes as we found. My patients have three checks: by my associate, by myself and by the aniseikonia technician. In many cases young persons return for a check with a cycloplegic, and we combine the results of all the refractions and incorporate them in the eikonic correction. I do not think these refractive changes are going to prove an important element in the end result. The question, I think, is whether the patients who are helped are the ones who get even a small change in refraction. Most of our patients do not seem to have a great deal of muscular trouble, but there are certainly a few who do. When anything obvious has been found, such as a bad muscle imbalance, we have not usually given the eikonic correction but have sent them back to the physician who referred them.

DR. LEGRAND H. HARDY, New York: I should like to mention two rather widespread misconceptions.

The first is that all, or most, aniseikonic patients are neurotic. While in many cases this is true, it most certainly is not true in all cases. Many physicians are likely to send neurotic patients to the aniseikonia clinic as a last resort or in the hope of being freed from them. This contributes considerably to the difficulties of formulating an accurate evaluation of aniseikonia and its clinical correction. The fact that a patient, having worn aniseikonic lenses for a period of from two months to two years, finds no further need for wearing them, in spite of the continuance of a demonstrable aniseikonia, does not prove that the condition was neurotic. The fact that among symptom-free subjects definite, and sometimes high, degrees of aniseikonia are found indicates the presence of a compensating mechanism. Such compensation, I believe, can be trained, and tolerances to size differences can be acquired and amplified.

The second misconception is that orthoptics is concerned with muscle imbalances (chiefly strabismus), and muscle imbalances only. This is not true.

I have rather imperfectly described orthoptic training as a method designed to develop or restore the normal, integrated binocular functions by means of graded exercises and training. It might possibly better be described as a series of methods used in the acquisition of ocular skills. Speed of fusion, speed of recognition, speed of adjustment and stereopsis, among other skills, are all subject to improvement through training. According to the more generalized view, aniseikonia will probably fall within the ambit of orthoptics. Our technician at the Eye Institute has frequently encountered great difficulties in measuring the aniseikonia, particularly for near

vision, in subjects who have developed a high amplitude of fusion. The fusion training has greatly modified the aniseikonic picture.

Johannes Müller: A Sketch of His Life and Ophthalmologic Works. Dr. Burton Chance, Philadelphia.

This paper was published in full in the November 1944 issue of the Archives, page 395.

DISCUSSION

Dr. F. H. Verhoeff, Boston: I should like to ask Dr. Chance whether he could say something about the circle of Müller? I should like to know what Müller called it, what importance he gave to it and who first attached his name to it. No doubt if he had attempted to define aniseikonia, he would have done so in terms of corresponding points. The Dartmouth group do not mention corresponding points when they attempt to define this condition.

Visual Symptoms Caused by Digitalis. Dr. Frank D. Carroll, New York.

Digitalis in normal dosage may produce visual symptoms with little or no other evidence of drug intoxication. Four cases seen by the author were reported. Two of the patients stated that everything appeared covered with snow; one, that she saw shiny objects "like goldfish," and the fourth complained of bright floating spots in her visual fields. All these symptoms disappeared within five days when the drug was stopped.

DISCUSSION

Dr. T. H. Johnson, New York: The hallucinations in Dr. Carroll's cases could have been caused by a toxic effect of the digitalis on the retina or on the higher visual centers. There are two areas in the occipital cortex which respond to stimuli, the visiosensory and the visiopsychic centers. Stimulation of the visiosensory area may produce hallucinations which consist of flashes of light, luminosities or spectral appearances, while stimulation of the visiopsychic area recalls stored memory pictures and reproduces panoramas, pictured scenes and scenes of action. The theory generally accepted is that crude visual hallucinations are the response to stimulation of the conduction tracts or higher centers in the occipital lobe, while complex phenomena are the result of the stimulation of the afferent visual pathways. However, it is well known that local lesions in the retina produce crude hallucinations. All ophthalmologists have had cases in which local changes in the retina have produced flashes of light and luminous scintillations, and there are many reports in the literature of crude hallucinations which were caused by local retinal lesions. The temporary loss of vision may be explained by the fact that the retinal arteries may have become spastic under the influence of the drug, causing temporary loss of vision, such as is often associated with arteriolar spasm in arterial hypertension. It would be hard to differentiate between obscuration of vision caused by spasm of the retinal arterioles and that caused by spasm of the arteries in the occipital lobe.

Dr. Frank D. Carroll, New York: I want to thank Dr. Johnson for his comment. All can profit by rereading his thesis on visual hallucinations presented before this society some years ago (*Tr. Am. Ophth. Soc.* **31:** 344, 1933). It still remains one of the outstanding works on this topic. As to his suggestion regarding the possibility that the visual symptoms due to digitalis may be associated with vasospasm of the retinal vessels: I have not observed any such change and think that in all probability there is a direct toxic action on the cells of the central nervous system.

Dr. D. F. Gillette, of Syracuse, has, I think, made an important contribution on this subject. He has just sent me the report of 2 cases of retrobulbar neuritis due to digitalis. Both patients had central scotomas and marked reduction of vision. Both recovered promptly when use of the drug was stopped. One had a temporary recurrence when again placed under medication with digitalis. This quickly disappeared after the drug was stopped. So far as I know, these are the first definite cases of retrobulbar neuritis due to digitalis clearly described, and I hope Dr. Johnson will report them in detail.

Albinism with Coexisting Anomalies of the Central Nervous System. Dr. C. P. Clark, Indianapolis.

A brief discussion of albinism was given. A few case histories were reviewed, and anomalies accompanying albinism, particularly of the central nervous system, were noted.

DISCUSSION

Dr. Harry S. Gradle, Chicago: This excellent paper by Dr. Clark presents so many opportunities for discussion of various phases that I wish to limit myself to one particular aspect, namely, the histologic picture.

The first description of albinism was made by Fritsch in 1907, but it was not until 1913 that Elschnig presented serial sections of an albinotic eye. I wish to quote from his article (*Arch. f. Ophth.* **84:** 401, 1913): "Serial sections showed the absence of a fovea centralis. In this central area of the albinotic eye the ganglion cell layer was somewhat thickened, as in the normal eye, and the nerve fiber layer was reduced to a layer of very delicate nerve fibers, which could be differentiated sharply from the membrana limitans interna, in an area of about 6 mm. diameter. In the center of this area, the rods and cones were somewhat elongated, and the external nuclear layer was somewhat thinned and merged indistinctly with the 'sponged-over' inner nuclear layer. The other layers were about normal."

These findings were later corroborated by Gilbert, Velhagen and Usher.

Such lack of foveal differentiation can easily be detected ophthalmoscopically in cases in which the nystagmus can be controlled. There are to be seen only a slight depression of the fovea and a marked diminution in the foveal reflex.

Anatomically, this picture is much the same as that shown in the embryonic eye between the sixth and the seventh month, according to Bach and Seefelder. The correlation of the ophthalmoscopic and the histologic picture explains the poor vision in these cases.

May I add a point found in practical experience? When such albinotic children are fitted between the ages of 8 and 12 years, they are able to use telescopic spectacles so satisfactorily that their collegiate education can be completed without great difficulty.

Amyloid Disease of the Conjunctiva. Dr. Norma B. Elles, Houston, Texas.

A discussion of primary and secondary amyloid disease of the conjunctiva was given, with presentation of a case of the primary type which had been under observation for three years.

The nature of amyloid and the process of its formation in the tissues are still debatable. Various more recent experimental investigations on amyloid, from both the pathologic and the biochemical viewpoints, were reviewed.

Amyloid disease is to be differentiated from hyaline degeneration and plasmoma.

DISCUSSION

Dr. Algernon B. Reese, New York: Dr. Elles has presented the most thoroughly studied case of amyloid disease of the eye that I have encountered on record. She has made a particular effort to rule out a virus infection as a factor. In her paper, she gives a complete discussion of the literature and the theories advanced. She champions the theory that the disease is a disturbance of protein metabolism whereby the rate of formation of catabolic protein products exceeds the ability of the tissue to dispose of them. She believes that there should be surgical removal of redundant areas which are disfiguring or which jeopardize the cornea. The disease in her case showed slow regression with the administration of fresh liver and preparations of vitamins A and C.

Diabetic Iridopathy. Dr. C. A. Clapp, Baltimore.

There frequently occur in the course of diabetes mellitus cellular changes in the iris, especially in the pigmented epithelium, which are not inflammatory. These changes should be termed iridopathy instead of iritis, just as noninflammatory retinal lesions are termed retinopathy instead of retinitis.

DISCUSSION

Dr. W. P. Beetham, Boston: Changes in the iris attributed to diabetes can be grouped as follows:

In the first group are the changes of inflammatory nature. In my opinion, this group deserves no further comment. Iritis and uveitis present the same frequency, etiologic factors, course and prognosis, irrespective of whether diabetes exists or not.

The second group consists of pupillary abnormalities. This, likewise, is of minor interest at present.

The third group consists of changes characterized by capillary proliferation. A vascular membrane is not uncommonly seen on the iris with various pathologic conditions. When the vessels are of sufficient size to be recognized grossly, "rubeosis iridis" exists. This vascularization occurs often with hemorrhagic glaucoma; hemorrhagic glaucoma occurs not infrequently with diabetes, hence the term "rubeosis iridis diabetica." In all of these eyes glaucoma either is present or soon develops. All eyes exhibiting such vascular changes on the iris present similar vascular changes in the retina, "diabetic retinopathy."

The fourth group represents changes in the retinal pigment epithelium. One of the commonest of lesions, as Dr. Clapp has pointed out, is the edema and cystic degeneration of the retinal pigment layer. With the necrosis of the pigment epithelium, small vesicles form which contain pigment granules, fragmented nuclei and glycogen.

Dr. Clapp's suggestion of using the term "iridopathy," as meaning changes in the iris of noninflammatory character, is most agreeable. I wonder, however, whether the term should include both glycogen infiltration and vascularization of the iris. The similar term retinopathy refers chiefly to vascular proliferation in the retina, and it would seem that the term iridopathy should refer to similar changes in the iris. The word, therefore, would have little meaning if limited to this use. If, on the contrary, it is used to designate cystic degeneration and glycogen infiltration, it refers to a condition dissimilar to that indicated by the corresponding term retinopathy. If it is used to designate these changes, the term will not be used clinically, as the actual diagnosis of these alterations must really be made pathologically.

Dr. A. B. Reese, New York: Has Dr. Clapp any explanation of the fact that these changes occur only in the pigment epithelium of the iris, and not in the pigment epithelium elsewhere?

Dr. C. A. Clapp, Baltimore: In the first place, I feel that the term iridopathy should not be

limited to diabetic conditions alone. I tried to limit this report to this one phase of the disease of the iris, but I believe that similar changes may occur in other diseases, as well as in diabetes.

Angioid Streaks in the Deep Layers of the Retina. Dr. Arthur J. Bedell, Albany, N. Y.

Stereoscopic examinations confirmed by photographs prove that these curious, frayed-edged streaks are anterior to areas of choroidal destruction and posterior to the retinal vessels. The progressive changes in the fundus which had gradually taken place during several years of observation were recorded. A study of them gave the warranted impression that the streaks found in conjunction with choroiditis, senile macular degeneration and papilledema are probably not the result of a common cause but represent the coincidence of the combination of separate diseases. Broad and extensive streaks have been seen in fundi that were otherwise normal.

DISCUSSION

Dr. Grady E. Clay, Atlanta, Ga.: In 1932, I was the first to publish in this country a report on the association of angioid streaks and pseudoxanthoma elasticum (Arch. Ophth. **8**: 334 [Sept.] 1932); since that time the reported association has become too frequent to be coincidental, and therefore the pathologic picture must be described. Since the original report, I have seen 63 more cases; in 30 per cent of these cases the streaks were associated with pseudoxanthoma elasticum, and in 15 per cent they were familial. I have found no other related disease in this group. Nineteen patients in my series were hospitalized, and a careful study of this group revealed no other associated disease. One patient with only a few streaks died recently of hypertensive disease. An autopsy was performed, and one eye was obtained. The complete report is not yet ready for publication.

I still believe that the disease is one of the blood vessels associated with degeneration of elastic tissue and that the earliest changes seen are hemorrhages and the formation of the streaks in the choroid. After this acute period has passed, which may be a year or two, hemorrhages are rarely seen, and no more streaks develop; from this time on there is a slowly developing choroidal atrophy in the areas of the streaks, and in these areas the streaks will entirely disappear. Why should there develop such a definite area of choroidal atrophy if this disease is not primarily a disease in the choroid, and a disease of the blood vessels?

In my opinion, the true pathologic picture is not yet known, and unless one is fortunate in securing an eye early in the course of the disease, it will not be known, for secondary changes too greatly alter the pathologic picture.

Toxoplasmosis: Report of Ocular Findings in Twins. Dr. Parker Heath, Detroit.

This paper was published in full in the March 1945 issue of the Archives, page 184.

DISCUSSION

Dr. Wendell H. Hughes, Hempstead, N. Y.: Does not this condition have an acute stage? There must be one, but I have not seen it described.

Dr. Alan C. Woods, Baltimore: I should like to ask Dr. Heath whether he is interested in toxoplasmosis as a possible cause of choroiditis and whether he has had any experience in regard to such a relation.

Penicillin Therapy in Ophthalmology. Dr. John H. Dunnington and Dr. Ludwig von Sallmann (by invitation), New York.

This paper was published in full in the November 1944 issue of the Archives, page 353.

DISCUSSION

Dr. E. V. L. Brown, Chicago: This paper, even with its small series of clinical cases, is especially welcome at this time because penicillin has so recently been made available to civilians that few have had opportunity to use it. I have had no such opportunity and must content myself with asking a single question—In view of the relatively small harm which the authors have found that penicillin produces when injected into the rabbit's vitreous and its favorable effect when injected within six to twelve hours after experimental infection of the vitreous, would it now be in order to inject penicillin (early) in cases of severe penetrating wounds of the eye when, say, the lens has been injured and the vitreous body supposedly opened to infection?

Dr. F. H. Verhoeff, Boston: I should like to ask the essayists whether they have investigated the action on retinal function when penicillin in effective concentration was injected into the vitreous. I recall one infected human eye in which injection of a different germicide into the vitreous overcame the infection without producing obvious damage, yet completely blinded the eye.

Dr. Alan C. Woods, Baltimore: The use of penicillin is new, and every one's experience is limited. For some time a crude penicillin has been available which has been used with rather conspicuous success in corneal baths or by instillation in cases of staphylococcic conjunctivitis. The purified penicillin has been used by iontophoresis in 8 or 10 cases of staphylococcic corneal ulcers. The results have been distinctly encouraging. It has been used in 2 or 3 cases of purulent panophthalmitis, by direct injection into the eye. In 1 case a trephination had been done on an eye before the man was admitted with

panophthalmitis. There was no improvement with the sulfonamide drugs. He was then given an injection of penicillin directly into the eye; but it had no effect on the disease, and the eye was lost. In another case intraocular injections had no effect. The results of intraocular injections are limited and not outstanding.

DR. LUDWIG VON SALLMANN, New York: With reference to Dr. Brown's question, a single injection of a small amount of highly purified penicillin may be regarded as a reasonably safe therapeutic procedure considering the unfavorable prognosis of ectogenous infections of the vitreous. This type of injection was applied in 1 case in which clinical signs of panophthalmitis existed; the acute inflammatory signs regressed, but it is too early to judge whether some vision will be restored.

Combined Intracranial and Orbital Operation for Retinoblastoma. DR. CHARLES E. G. SHANNON, Philadelphia.

A case of bilateral retinoblastoma was reported in which the combined intracranial and orbital operation as suggested by Jean, in 1924, was carried out with apparent success on both eyes. Merits of this operation are discussed.

DISCUSSION

DR. ALGERNON B. REESE, New York: In 1931 (ARCH. OPHTH. **5:** 269 [Feb.] 1931) I published the results of the microscopic examination of 119 eyes enucleated with the diagnosis of retinoblastoma. In 43 per cent of the eyes the operative section through the optic nerve was not beyond the extension of the tumor, and therefore residual tumor had apparently been left in that portion of the optic nerve which remained in the orbit. For some time I have felt that these figures are not consistent with those for current cases. Therefore, a similar study was made of 65 eyes enucleated during the past eight years at the Institute of Ophthalmology or at the Memorial Hospital for the Treatment of Cancer and Allied Diseases. Of this group, the tumor had extended into the optic nerve beyond the lamina cribrosa in only 15 eyes, or 23 per cent. The tumor had extended beyond the site where the nerve was severed at operation in only 4 eyes, or 6 per cent. The tumor had extended through the sclera in 7 eyes, or 11 per cent.

The eyes in the older group were enucleated in the period between 1878 and 1929 (fifty-one years), while the eyes in the recent group were enucleated in the period between 1934 and 1942 (eight years). The discrepancy in the figures for these two series seems to be due to the fact that in the older group a diagnosis was not made as early and the optic nerve stump left attached to the sclera was not as long as in the more recent group. The increasingly lower mortality figures in the past seventy-five years also bespeak earlier diagnosis and the leaving of a longer optic nerve stump at the time of enucleation.

If the optic nerve is severed properly at the time of operation, there is little chance that residual tumor will be left in that portion of the nerve remaining in the orbit. The firm tissue of the optic nerve offers resistance to tumor invasion, and seldom does a tumor extend into the nerve for more than a few millimeters, and practically never as much as 8 to 10 mm.

Pathogenesis of Intermittent Exophthalmos. DR. FRANK B. WALSH and DR. WALTER E. DANDY (by invitation), Baltimore.

This paper was published in full in the July 1944 issue of the ARCHIVES, page 1.

DISCUSSION

DR. W. L. BENEDICT, Rochester, Minn.: Intermittent exophthalmos is a rare clinical phenomenon due to venous aneurysm within the orbit and occurs probably only in cases of congenital vascular anomalies. It is to be distinguished from pulsating exophthalmos, which usually is the result of trauma, and the authors have defined the terms with this in mind.

Three cases of intermittent exophthalmos have been seen at the Mayo Clinic, and in only 1 of them was operation performed.

DR. FRANK B. WALSH, Baltimore: I wish to thank Dr. Benedict for his interesting comments. It is gratifying that he seems to be in agreement regarding the production of intermittent exophthalmos by developmental vascular abnormalities.

As regards surgical intervention when indicated in such cases, Dr. Benedict seems in agreement with respect to the transcranial approach.

Recurrent Erosion of the Cornea. DR. PAUL A. CHANDLER, Boston.

Various types of recurrent erosion of the cornea were described; the literature was reviewed; possible etiologic factors were discussed, and various forms of treatment were evaluated.

DISCUSSION

DR. RALPH I. LLOYD, Brooklyn: I venture to suggest that in most of the cases reported the erosion was postherpetic. I have a number of similar cases under observation in which there have been recurrences over a period of twelve to fifteen years.

The best treatment is prevention of recurrence by using the moist chamber spectacles or the expansion shield, which can be applied and removed from the spectacles easily.

The herpetic patient carries the virus in the conjunctival sac, and slight trauma allows it to

enter the epithelial layer. Such a patient does not recover full sensation of the cornea; and when the sensation diminishes, there are lowered vitality and recurrence or reinfection.

In some cases of keratitis sicca, lattice dystrophy and Fuchs's dystrophy, the lesions are similar, but the differential diagnosis should not be difficult.

Dr. Paul A. Chandler, Boston: The neuropathic theory is difficult either to prove or to disprove. My reason for feeling that a damaged endothelium may be a factor is the close analogy between recurrent erosion and vesicular or bullous keratitis, which is evidently due to a defective endothelium.

In regard to changes in sensitivity which Dr. Lloyd mentioned: Some of these corneas are hypersensitive, some are normal and some are insensitive; and it is hard to draw any conclusion. It depends on how long the trouble has been present and how severe the bullous keratitis is. In the early stages the pain may be severe, but later the nerve endings are destroyed and there is less pain. Recurrent attacks of herpes are common, but I believe this condition is a different disease than ordinary recurrent erosion of the cornea. In regard to Dr. Lloyd's suggestion of wearing protective spectacles to conserve moisture, according to my experience this is the wrong thing to do. As I mentioned before, if one prevents evaporation of tears and thus lowers their osmotic tension, there is more likely to be trouble, as witnessed by the occurrence of attacks after sleep and after weeping. Dr. Post's case in which relief was obtained with use of a thermophore treatment illustrates another simple method of treating the disorder. Patients with the microform of this disease usually will not submit to radical treatment; and if given 10 per cent boric ointment to use in the eye at night and instructed to observe care in opening the eyes in the morning, they will get on with a minimum of trouble.

Mitotic and Wound-Healing Activities of the Corneal Epithelium. Dr. Jonas S. Friedenwald and Dr. Wilhelm Buschke (by invitation), Baltimore.

This paper was published in full in the November 1944 issue of the Archives, page 410.

DISCUSSION

Dr. F. H. Verhoeff, Boston: This painstaking and laborious investigation is of great scientific interest and importance. The essayists have not attempted to apply their results to clinical problems, but no doubt will do so later. They confirmed and utilized the remarkable fact that colchicine can stop mitosis in the metaphase without otherwise interfering with cell divison or checking the entrance of cells into it. They found no drug whose effect was similar. It would seem, however, that the effect of cold was somewhat similar, since they state that it froze the cells in metaphase without abolishing the other phases of mitosis. A notable discovery was that cervical ganglionectomy reduced the number of cells entering into mitosis and slowed the mitotic cycle. No explanation of these effects was attempted.

The essayists found that localized damage to the corneal epithelium inhibited mitosis in the surrounding cells. They also found that exposure of the corneal epithelium to ultraviolet light notably inhibited mitosis in the exposed area.

The essayists found nothing that stimulated mitosis. Apparently they did not try the effect of heat. I found that heat generated by radiant energy stimulated mitosis in the corneal corpuscles and in the capsular epithelium. In one experiment I focused sunlight on the highly pigmented iris of a rabbit. This caused necrosis of the iris in the exposed area and produced in the capsular epithelium behind this area the most abundant and beautiful mitoses I have ever seen—almost every cell was in some stage of mitosis. The capsular epithelium is particularly well suited for such experimentation because it consists of but a single layer and the lens is free from nerves and blood vessels. Among the agents tested by the essayists, I note the absence of scarlet red (sudan IV), commonly believed to be a stimulant to epithelial repair.

The essayists state, in confirmation of other investigators, that epithelial defects in the cornea, even large ones, are repaired by cell migration without multiplication. I should like to ask whether they excluded the possibility that amitotic cell division played a part in the healing process. I found that it occurred in capsular epithelium injured by ultraviolet light. I should also like to ask whether the essayists determined when mitosis began in a repaired area.

The essayists state that even severe exposure to ultraviolet light does not inhibit wound healing. I take it that they found that an exposure which markedly inhibited mitosis did not interfere with the healing of small traumatic defects in the exposed area. This is certainly a remarkable fact. Still more remarkable is their finding that repair can be made by epithelium so severely exposed that it later sloughs off. Their statement that after an exposure which causes sloughing of the epithelium repair promptly begins at the margin of the slough is perhaps of doubtful significance, since the cells making the repair may have received slight, if any, exposure.

Dr. Jonas S. Friedenwald, Baltimore: Dr. Verhoeff's question as to the possible presence of amitotic division is one which we are unable to answer. We have seen no cells in our preparations

with double nuclei, but our failure to find such cells does not rule out the possibility of amitotic division. Current trends of thought among biologists have raised doubts as to the existence of amitotic division as a general phenomenon. In many of the instances in which this type of division was formerly thought to have taken place only mitotic division has been exhibited. In regard to the cornea, the question is still open.

Retrolental Fibroplasia in Premature Infants: V. Further Studies on Fibroplastic Overgrowth of the Persistent Tunica Vasculosa Lentis. DR. T. L. TERRY, Boston.

This paper was published in full in the January 1945 issue of the ARCHIVES, page 203.

DISCUSSION

DR. E. V. L. BROWN, Chicago: I have operated in 1 case—on each eye, as advised by Dr. Terry. It is too early to determine the results. I am extremely interested in the subject because for years back my associates and I have been taking out such eyes, fearing glioma. After seeing the patient, Drs. Bothman, Kronfeld, Kraus, Stough, Fralick and I would each write down separately what we thought the diagnosis should be. I do not know who was wrong most of the time, but I think we were all wrong many times. We have mistaken retrolental fibroplasia for glioma in many cases. In 4 or 6 enucleated eyes seen between 1935 and 1940 there was really retrolental fibroplasia.

News and Notes

GENERAL NEWS

Postgraduate Course in Ophthalmology, Washington School of Medicine.—The Department of Ophthalmology, Washington University School of Medicine, will resume its eight month postgraduate course on Oct. 1, 1945. The course will be limited in number. For further details, address Dr. Lawrence T. Post, 640 South Kingshighway Boulevard, St. Louis 10, Mo.

American Board of Ophthalmology.—The examination of the American Board of Ophthalmology, which was to have been held in Chicago in October, has been postponed until January 1946.

Examinations during 1946 will be held in Chicago, January 18 to 22; in Los Angeles, January 28 to February 1; in New York, in May or June, and in Chicago, in October.

Book Reviews

A Bibliography of Visual Literature 1939-1944. Compiled by John F. Fulton, Phebe M. Hoff and Henrietta T. Perkins. Prepared for the Committee on Aviation Medicine, Division of Medical Sciences, National Research Council Acting for the Committee on Medical Research, Office of Scientific Research and Development, Washington, D. C. Price, $3. Pp. 117. Springfield, Ill.: Charles C Thomas, Publisher, 1945.

In present day warfare the demands placed on the eyes are greater than ever, with special application to the airplane and black-out regulations. Vision has assumed such widespread military importance that the British Air Ministry requested assistance in the compilation of a classified bibliography covering all literature on vision that might have bearing on military operations on land, at sea or in the air. "A Bibliography of Aviation Medicine" was compiled by E. C. Hoff and John F. Fulton, in 1942, and its "Supplement," by P. M. Hoff, E. C. Hoff and John F. Fulton, in 1944. These compilations serve as a pattern for the present volume. In addition to the biologic and psychologic aspects, special attention has been concentrated on physiologic questions concerned with night vision, color vision and perceptual problems. The extensive literature on visual examination and testing of military personnel is fully covered. In the section on therapy, attention is drawn to the newer developments, both surgical and chemotherapeutic, and a separate section on trachoma is added.

The book is extremely useful as a guide to recent literature, particularly as many of the articles abstracted are from other than ophthalmologic journals. Attention, naturally, has been concentrated on the biologic aspects of ophthalmology, and the book does not intend to be complete in all phases of general ophthalmology or ocular pathology. It is so well indexed that much time will be saved for any one looking up the literature on a particular subject.

F. H. Adler.

Refraction of the Eye. By Alfred Cowan, M.D. Second Edition, thoroughly revised. Price, $4.75. Pp. 278, including index, with 172 engravings and 3 colored plates. Philadelphia: Lea & Febiger, 1945.

The first edition of Dr. Cowan's careful work on "Refraction of the Eye" was published in 1938 and was well received. This second edition, although it contains fewer pages, is really an amplification, since more material has gone into a different format. It is not simply a reprint. Every page has been carefully reviewed, and numerous deletions and additions have been made. Many of the engravings have been improved and clarified. In addition, the chapters have been rearranged to bring relevant and sequential material into closer relationship.

Any one who undertakes the task of writing a book on clinical refraction, particularly if it is to be used as a guide for beginners, faces great difficulties. All necessary optics can be quickly and effectively discussed. But the various methods to be used and solutions to be found for particular difficulties present a formidable array. The evaluation and application of such methods and solutions require not only prolonged practical experience but great aptitude in expression. Dr. Cowan has had the experience and can express himself cogently.

The book can be highly recommended for any one practicing, or intending to practice, ophthalmology.

LeGrand H. Hardy.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e, France.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6e, France.

International Ophthalmologic Congress

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.
Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 17 Horseferry Rd., London, England.

Pan-American Congress of Ophthalmology

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Executive Secretaries: Dr. Conrad Berens, 35 E. 70th St., New York. Dr. M. E. Alvaro, 1511 Rua Consolacão, São Paulo, Brazil.

FOREIGN

All-India Ophthalmological Society

President: Dr. B. K. Narayan Rao, Minto Ophthalmic Hospital, Bangalore.
Secretary: Dr. G. Zachariah, Flitcham, Marshall's Rd., Madras.

British Medical Association, Section on Ophthalmology

President: Dr. W. Clark Souter, 9 Albyn Pl., Aberdeen, Scotland.
Secretary: Dr. Frederick Ridley, 12 Wimpole St., London, W. 1.

Chengtu Ophthalmological Society

President: Dr. Eugene Chan.
Secretary: Dr. K. S. Sun.
Place: Eye, Ear, Nose and Throat Hospital, Chengtu, China.

Chinese Ophthalmology Society

President: Dr. C. H. Chou, 363 Avenue Haig, Shanghai.
Secretary: Dr. F. S. Tsang, 221 Foochow Rd., Shanghai.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

Faculty of Ophthalmologists

President: Brig. Sir Stewart Duke-Elder, 63 Harley St., London, W. 1, England.
Secretary: Mr. Frank W. Law, 45 Lincoln's Inn Fields, London, W. C. 2., England.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.

Hungarian Ophthalmological Society

President: Prof. I. Imre, Budapest.
Assistant Secretary: Dr. Stephen de Grósz, University Eye Hospital, Máriautca 39, Budapest.
All correspondence should be addressed to the Assistant Secretary.

Midland Ophthalmological Society

President: Dr. W. Niccol, 4 College Green, Gloucester, England.
Secretary: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Place: Birmingham and Midland Eye Hospital.

North of England Ophthalmological Society

President: Mr. John Foster, 45 Park Sq., Leeds.
Secretary: Mr. William M. Muirhead, 70 Upper Hanover St., Sheffield.
Place: Manchester, Bradford, Leeds, Newcastle-upon-Tyne, Liverpool and Sheffield, in rotation. Time: October to April.

Ophthalmological Society of Australia

President: Dr. N. McAlister Gregg, 193 Macquarie St., Sydney.
Secretary: Dr. D. A. Williams, 27 Commonwealth St., Sydney.
Place: Sydney:. Time: Oct. 3-6, 1945.

Ophthalmological Society of Egypt

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.
All correspondence should be addressed to the secetary, Dr. Mohammed Khalil.

Ophthalmological Society of South Africa

President: Dr. A. W. Sichel, National Mutual Bldg., Church Square, Cape Town.
Secretary: Dr. J. K. de Kock, Groote Kerk Bldg., 32 Parliament St., Cape Town.

Ophthalmological Society of the United Kingdom

President: Mr. Charles B. Goulden, 89 Harley St., London.
Secretary: Mr. Frank W. Law, 30 Devonshire Pl., London, W. 1.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Rd., Bombay 4, India.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and keep it up to date.

Oxford Ophthalmological Congress

Master: Mr. P. G. Doyne, 60 Queen Anne St., London, W. 1, England.
Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

Palestine Ophthalmological Society

President: Dr. Arieh Feigenbaum, Abyssinian St. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel Aviv.

Polish Ophthalmological Society

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

Royal Society of Medicine, Section of Ophthalmology

President: Col. F. A. Juler, 96 Harley St., London, W. 1, England.
Secretary: Dr. Harold Ridley, 60 Queen Anne St., London, W. 1, England.

São Paulo Society of Ophthalmology

President: Silvio de Almeida Toledo, Barão de Ilapetininga St., 88, 5º Andar, São Paulo, Brazil.
Secretary: Dr. Plinio de Toledo Piza, Enfermaria Santo Luzia, Santa Casa de Misericordia, Cesario Motta, St. 112, São Paulo, Brazil.

Scottish Ophthalmological Club

President: Dr. S. Spence Meighan, 13 Woodside Pl., Glasgow, C. 3.
Secretary: Dr. Alexander Garrow, 15 Woodside Pl., Glasgow, C. 3.
Place: Edinburgh and Glasgow, in rotation.

Sociedad Argentina de Oftalmologia

Chairman: Dr. Jorge Malbrán, Buenos Aires.
Secretary: Dr. Benito Just Tiscornia, Santa Fe 1171, Buenos Aires.

Sociedad Oftalmologia del Litoral, Rosario (Argentina)

President: Prof. Dr. Carlos Weskamp, Laprida 1159, Rosario.
Secretary: Dr. Arturo Etchemendigaray, Villa Constitución, Santa Fé.
Place: Rosario. Time: Last Saturday of every month, April to November. All correspondence should be addressed to the President.

Sociedade de Oftalmologia de Minas Gerais

President: Prof. Hilton Rocha, Rua Rio de Janeiro 2251, Bello Horizonte, Minas Geraes, Brazil.
Secretary: Dr. Ennio Coscarelli, Rua Aimorés 1697, Bello Horizonte, Minas Geraes, Brazil.

Sociedade de Oftalmologia e Otorrinolaringologia de Rio Grande do Sul

President: Dr. Luiz Assumpção Osorio, Edificio Vera Cruz, Apartamento 134, Porto Alegre, Rio Grande do Sul.
Secretary: Dr. Fernando Voges Alves, Caixa Postal 928, Porto Alegre, Rio Grande do Sul.

Sociedade de Ophthalmologia e Oto-Rhino-Laryngologia da Bahia

President: Dr. Theonilo Amorim, Barra Avenida, Bahia, Brazil.
Secretary: Dr. Adroaldo de Alencar, Brazil.
All correspondence should be addressed to the President.

Società Oftalmologica Italiana

President: Prof. Dott. Giuseppe Ovio, Ophthalmological Clinic, University of Rome, Rome.
Secretary: Prof. Dott. Epimaco Leonardi, Via del Gianicolo, 1, Rome.

Société Française d'Ophtalmologie

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7e.

Society of Swedish Ophthalmologists

President: Prof. K. G. Ploman, Stockholm.
Secretary: Dr. K. O. Granström, Södermalmstorg 4, III tr., Stockholm, Sö.

Tel Aviv Ophthalmological Society

President: Dr. D. Arieh-Friedman, 96 Allenby St., Tel Aviv, Palestine.
Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. Frederick C. Cordes, 384 Post St., San Francisco.
Secretary: Dr. R. J. Masters, 23 E. Ohio St., Indianapolis.
In compliance with the request of the Office of Defense Transportation and in the interest of the national war effort a meeting will not be held in 1945.

American Academy of Ophthalmology and Otolaryngology, Section on Ophthalmology

President: Dr. Gordon B. New, Mayo Clinic, Rochester, Minn.
President-Elect Dr. Alan C. Woods, Johns Hopkins Hospital, Baltimore 5.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100–1st Ave. Bldg., Rochester, Minn.

American Ophthalmological Society

President: Dr. S. Judd Beach, 704 Congress St., Portland, Maine.
Secretary-Treasurer: Dr. Walter S. Atkinson, 129 Clinton St., Watertown, N. Y.

Association for Research in Ophthalmology, Inc.

Chairman: Dr. Conrad Berens, 35 E. 70th St., New York.
Secretary-Treasurer: Major Brittain F. Payne, School of Aviation Medicine, Randolph Field, Texas.
Assistant Secretary-Treasurer: Dr. Hunter Romaine, 35 E. 70th St., New York.

Canadian Medical Association, Section on Ophthalmology

President: Dr. Alexander E. MacDonald, 170 St. George St., Toronto.
Secretary-Treasurer: Dr. L. J. Sebert, 170 St. George St., Toronto.

Canadian Ophthalmological Society

President: Dr. R. Evatt Mathers, 34½ Morris St., Halifax, N. S.
Secretary-Treasurer: Dr. Kenneth B. Johnston, Suite 1, 1509 Sherbrooke St. W., Montreal.

National Society for the Prevention of Blindness

President: Mr. Mason H. Bigelow, 1790 Broadway, New York.
Secretary: Miss Regina E. Schneider, 1790 Broadway, New York.
Executive Director: Mrs. Eleanor Brown Merrill, 1790 Broadway, New York.

SECTIONAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear Nose and Throat

President: Dr. N. Zwaifler, 46 Wilbur Ave., Newark.
Secretary: Dr. William F. Keim Jr., 25 Roseville Ave., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Central Illinois Society of Ophthalmology and Otolaryngology

President: Dr. Watson Gailey, 1000 N. Main St., Bloomington, Ill.
Secretary-Treasurer: Dr. William F. Hubble, 861-867 Citizens Bldg., Decatur, Ill.

Central Wisconsin Society of Ophthalmology and Otolaryngology

President: Dr. L. J. Friend, 425 E. Grand Ave., Beloit, Wis.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.

New England Ophthalmological Society

President: Dr. Theodore L. Terry, 140 Marlborough St., Boston.
Secretary-Treasurer: Dr. Merrill J. King, 264 Beacon St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. D. H. O'Rourke, 1612 Tremont Pl., Denver.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. James H. Mathews, 1317 Marion St., Seattle, Wash.
Secretary-Treasurer: Dr. Barton E. Peden, 301 Stimson Bldg., Seattle 1.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month except June, July and August.

Rock River Valley Eye, Ear, Nose and Throat Society

President: Dr. J. Sheldon Clark, 27 E. Stephenson St., Freeport, Ill.
Secretary-Treasurer: Dr. Harry R. Warner, 321 W. State St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

Saginaw Valley Academy of Ophthalmology and Otolaryngology

President: Dr. L. D. Gomon, 308 Eddy Bldg., Saginaw, Mich.
Secretary-Treasurer: Dr. Harold H. Heuser, 207 Davidson Bldg., Bay City, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July, August and September.

Sioux Valley Eye and Ear Academy

President: Dr. J. C. Decker, 515 Francis Bldg., Sioux City, Iowa.
Secretary-Treasurer Dr. J. E. Dvorak, 408 Davidson Bldg., Sioux City, Iowa.

Southern Medical Association, Section on Eye, Ear, Nose and Throat

Chairman: Dr. John H. Burleson, 414 Navarro St., San Antonio, Texas.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville, S. C.

Southwestern Academy of Eye, Ear, Nose and Throat

President: Dr. H. L. Brehmer, 221 W. Central Ave., Albuquerque, N. Mex.
Secretary: Dr. A. E. Cruthirds, 1011 Professional Bldg., Phoenix, Ariz.

Southwestern Michigan Triological Society

President: Dr. W. M. Dodge, 716 First National Bank Bldg., Battle Creek.
Secretary-Treasurer: Dr. Kenneth Lowe, 25 W. Michigan Ave., Battle Creek.
Time: Last Thursday of September, October, November, March, April and May.

Western Pennsylvania Eye, Ear, Nose and Throat Society

President: Dr. Ray Parker, 218 Franklin St., Johnstown, Pa.
Secretary-Treasurer: Dr. J. McClure, Tyson, Deposit Nat'l Bank Bldg., Dubois.

STATE

Arkansas State Medical Society, Eye, Ear, Nose and Throat Section

President: Dr. Raymond C. Cook, 701 Main St., Little Rock.
Secretary: Dr. K. W. Cosgrove, Urquhart Bldg., Little Rock.

Colorado Ophthalmological Society

President: Dr. C. A. Ringle, 912–9th Ave., Greeley.
Secretary: Dr. W. A. Ohmart, 1102 Republic Bldg., Denver.
Place: University Club, Denver. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

Connecticut State Medical Society, Section on Eye, Ear, Nose and Throat

President: Dr. F. L. Phillips, 405 Temple St., New Haven.
Secretary-Treasurer: Dr. W. H. Turnley, 1 Atlantic St., Stamford, Conn.

Eye, Ear, Nose and Throat Club of Georgia

President: Dr. William O. Martin Jr., Doctors Bldg., Atlanta.
Secretary-Treasurer: Dr. C. K. McLaughlin, 526 Walton St., Macon.

Indiana Academy of Ophthalmology and Oto-Laryngology

President: Dr. F. McK. Ruby, Union City.
Secretary: Dr. Edwin W. Dyar Jr., 23 E. Ohio St., Indianapolis.
Place: French Lick. Time: First Wednesday in April.

Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. J. K. Von Lackum, 117–3d St. S. E., Cedar Rapids.
Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

Kansas State Medical Society, Section on Ophthalmology and Otolaryngology

President: Dr. W. D. Pittman, Pratt.
Secretary: Dr. Louis R. Haas, 902 N. Broadway, Pittsburg.

Louisiana-Mississippi Ophthalmological and Otolaryngological Society

President: Dr. Val. H. Fuchs, 200 Carondelet St., New Orleans.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Medical Society of the State of Pennsylvania, Section on Eye, Ear, Nose and Throat Diseases

Chairman: Dr. Karl M. Houser, 2035 Delancey St., Philadelphia 3.
Secretary: Dr. William T. Hunt Jr., 1205 Spruce St., Philadelphia 7.

Michigan State Medical Society, Section of Ophthalmology and Otolaryngology.

Chairman: Dr. Robert H. Fraser, 25 W. Michigan Ave., Battle Creek.
Secretary: Dr. R. G. Laird, 114 Fulton St., Grand Rapids.

Minnesota Academy of Ophthalmology and Otolaryngology

President: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.
Secretary: Dr. William A. Kennedy, 372 St. Peter St., St. Paul.
Time: Second Friday of each month from October to May.

Montana Academy of Oto-Ophthalmology

President: Dr. William Morrison, 208 N. Broadway, Billings.
Secretary: Dr. Fritz D. Hurd, 309 Medical Arts Bldg., Great Falls.

Nebraska Academy of Ophthalmology and Otolaryngology

President: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. John Peterson, 1307 N. St., Lincoln.

New Jersey State Medical Society, Section on Ophthalmology, Otology and Rhinolaryngology

Chairman: Dr. George P. Meyer, 410 Haddon Ave., Camden.
Secretary: Dr. John P. Brennan, 429 Cooper St., Camden.

New York State Medical Society, Eye, Ear, Nose and Throat Section

Chairman: Dr. Harold J. Joy, 504 State Tower Bldg., Syracuse 2.
Secretary: Dr. Maxwell D. Ryan, 660 Madison Ave., New York 21.

North Carolina Eye, Ear, Nose and Throat Society

President: Dr. Hugh C. Wolfe, 102 N. Elm St., Greensboro.
Secretary: Dr. Vanderbilt F. Couch, 104 W. 4th St., Winston-Salem.

North Dakota Academy of Ophthalmology and Oto-Laryngology

President: Dr. W. L. Diven, City National Bank Bldg., Bismarck.
Secretary-Treasurer: Dr. A. E. Spear, 20 W. Villard, Dickenson.

Oregon Academy of Ophthalmology and Oto-Laryngology

President: Dr. Paul Neely, 1020 S. W. Taylor St., Portland.
Secretary-Treasurer: Dr. Lewis Jordon, 1020 S. W. Taylor St., Portland.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

Pennsylvania Academy of Ophthalmology and Otolaryngology

President: Dr. Lewis T. Buckman, 83 S. Franklin St., Wilkes-Barre.
Secretary Pro Tem: Dr. Paul C. Craig, 232 N. 5th St., Reading.
Time: Last week in April.

Rhode Island Ophthalmological and Otological Society

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society, Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

South Carolina Society of Ophthalmology and Otolaryngology

President: Dr. J. L. Sanders, 222 N. Main St., Greenville.
Secretary: Dr. J. H. Stokes, 125 W. Cheves St., Florence.

Tennessee Academy of Ophthalmology and Otolaryngology

President: Dr. Wesley Wilkerson, 700 Church St., Nashville.
Secretary-Treasurer: Dr. W. D. Stinson, 124 Physicians and Surgeons Bldg., Memphis.

Texas Ophthalmological and Oto-Laryngological Society

President: Dr. F. H. Rosebrough, 603 Navarro St., San Antonio.
Secretary: Dr. M. K. McCullough, 1717 Pacific Ave., Dallas.

Utah Ophthalmological Society

President: Dr. R. B. Maw, 699 E. South Temple, Salt Lake City.
Secretary-Treasurer: Dr. Charles Ruggeri Jr., 1120 Boston Bldg., Salt Lake City.
Place: University Club, Salt Lake City. Time: 7:00 p. m., third Monday of each month.

Virginia Society of Oto-Laryngology and Ophthalmology

President: Dr. Mortimer H. Williams, 30½ Franklin Rd. S. W., Roanoke.
Secretary-Treasurer: Dr. Meade Edmunds, 34 Franklin St., Petersburg.

West Virginia State Medical Association, Eye, Ear, Nose and Throat Section

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

Akron Academy of Ophthalmology and Otolaryngology

President: Dr. E. L. Mather, 39 S. Main St., Akron, Ohio.
Secretary-Treasurer: Dr. V. C. Malloy, 2d National Bank Bldg., Akron, Ohio.
Time: First Monday in January, March, May and November.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. B. M. Cline, 153 Peachtree St. N. E., Atlanta, Ga.
Acting Secretary: Dr. A. V. Hallum, 478 Peachtree St. N. E., Atlanta, Ga.
Place: Grady Hospital. Time: 6:00 p. m., fourth Monday of each month, from October to May.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Ernst Bodenheimer, 1212 Eutaw Pl., Baltimore.
Secretary: Dr. Thomas R. O'Rourk, 104 W. Madison St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to March.

Birmingham Eye, Ear, Nose and Throat Club

President: Each member, in alphabetical order.
Secretary: Dr. Luther E. Wilson, 919 Woodward Bldg., Birmingham, Ala.
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

Brooklyn Ophthalmological Society

President: Dr. Michael J. Buonaguro, 589 Lorimer St., Brooklyn.
Secretary-Treasurer: Dr. Benjamin C. Rosenthal, 140 New York Ave., Brooklyn 16.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. William H. Howard, 389 Linwood Ave., Buffalo 9.
Secretary-Treasurer: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo 9.
Time: Second Thursday of each month from October to May.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. Douglas Chamberlain, Chattanooga Bank Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. Samuel J. Meyer, 58 E. Washington St., Chicago 2.
Secretary: Dr. W. A. Mann, 30 N. Michigan Ave., Chicago 2.
Place: Continental Hotel, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati General Hospital Ophthalmology Staff

Chairman: Dr. D. T. Vail, 441 Vine St., Cincinnati.
Secretary: Dr. A. A. Levin, 441 Vine St., Cincinnati.
Place: Cincinnati General Hospital. Time: 7:45 p. m., third Friday of each month except June, July and August.

Cleveland Ophthalmological Club

Chairman: Dr. M. Paul Motto, Rose Bldg., Cleveland.
Secretary: Dr. H. H. Wygand, Guardian Bldg., Cleveland.
Time: Second Tuesday in October, December, February and April.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. W. S. Reese, 1901 Walnut St., Philadelphia.
Clerk: Dr. George F. J. Kelly, 37 S. 20th St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. Erwin W. Troutman, 21 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. T. Rees Williams, 380 E. Town St., Columbus 15, Ohio.
Place: University Club. Time: 6:15 p. m., first Monday of each month, from October to May, inclusive.

Corpus Christi Eye, Ear, Nose and Throat Society

Chairman: Dr. C. B. Collins, 704 Medical Professional Bldg., Corpus Christi, Texas.
Secretary: Dr. L. W. O. Janssen, 710 Medical Professional Bldg., Corpus Christi, Texas.
Time: 6:30 p. m., third Tuesday of each month from October to May.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. Ruby K. Daniel, Medical Arts Bldg., Dallas 1, Texas.
Secretary: Dr. Tom Barr, Medical Arts Bldg., Dallas 1, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. H. C. Schmitz, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Byron M. Merkel, 604 Locust St., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Cecil W. Lepard, 1025 David Whitney Bldg., Detroit 26.
Place: Club rooms of Wayne County Medical Society.
Time: First Wednesday of each month, November to April, inclusive.

Detroit Ophthalmological Society

President: Dr. Raymond S. Goux, 545 David Whitney Bldg., Detroit 26.
Secretary: Dr. Arthur Hale, 1609 Eaton Tower, Detroit 26.
Place: Club rooms of Wayne County Medical Society. Time: 6:30 p. m., third Thursday of each month from November to April, inclusive.

Eastern New York Eye, Ear, Nose and Throat Association

President: Appointed at each meeting.
Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. Rex Howard, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. R. H. Gough, Medical Arts Bldg., Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Ophthalmological and Oto-Laryngological Section

President: Dr. Lyle J. Logue, 1304 Walker Ave., Houston, Texas.
Secretary: Dr. John T. Stough, 803 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

Indianapolis Ophthalmoolgical and Oto-laryngological Society

President: Dr. Myron Harding, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. Edgar Johnson, 906 Grand Ave., Kansas City, Mo.
Secretary: Dr. W. E. Keith, 1103 Grand Ave., Kansas City, Mo.
Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Francis Carl Hertzog, 117 E. 8th St., Long Beach, Calif.
Secretary-Treasurer: Dr. Robert G. Thornburgh, 117 E. 8th St., Long Beach, Calif.
Place: Seaside Hospital. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Otolaryngology

President: Dr. Orrie E. Ghrist, 210 N. Central Ave., Glendale, Calif.
Secretary-Treasurer: Dr. K. C. Brandenburg, 110 Pine Ave., Long Beach 2, Calif.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time 6:30 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye and Ear Society

President: Dr. Joseph S. Heitger, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. J. W. Fish, 321 W. Broadway, Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Lower Anthracite Eye, Ear, Nose and Throat Society

Chairman: Each member in alphabetical order.
Secretary: Dr. James J. Monohan, 31 S. Jardin St., Shenandoah, Pa.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. P. S. Constantinople, 1835 I St. N. W., Washington.
Secretary: Dr. Frazier Williams, 1801 I St. N. W., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month from September to May.

Milwaukee Oto-Ophthalmic Society

President: Dr. Ralph T. Rank, 238 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. Frank G. Treskow, 411 E. Mason St., Milwaukee 2.
Place: University Club. Time: 6:30 p. m., fourth Tuesday of each month from October to May.

Montreal Ophthalmological Society

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel. Time: 6.30 p. m., first Tuesday of each month from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. J. Rosenbaum, 1396 Ste. Catherine St. W., Montreal, Canada.
Secretary: Dr. L. Tessier, 1230 St. Joseph Blvd. E., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. M. M. Cullom, 700 Church St., Nashville, Tenn.
Secretary: Dr. R. E. Sullivan, 432 Doctors Bldg., Nashville, Tenn.
Place: James Robertson Hotel. Time 6:30 p. m., third Monday of each month from October to May.

New Haven Ophthalmological Society

President: Dr. William H. Ryder, 185 Church St., New Haven, Conn.
Secretary: Dr. Frederick A. Wiess, 255 Bradley St., New Haven, Conn.

New Orleans Ophthalmological and Oto-laryngological Society

President: Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.
Secretary: Dr. Mercer G. Lynch, 1018 Maison Blanche Bldg., New Orleans.
Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to May.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. Thomas H. Johnson, 30 W. 59th St., New York.
Secretary: Dr. Wendell L. Hughes, 131 Fulton Ave., Hempstead, N. Y.
Time: 8 p. m., second Tuesday of each month from October to May, inclusive.

New York Society for Clinical Ophthalmology

President: Dr. Maurice L. Wieselthier, 1322 Union St., Brooklyn.
Secretary: Dr. Benjamin Esterman, 983 Park Ave., New York 28.
Place: New York Academy of Medicine, 2 E. 103d St. Time: 8 p. m., first Monday of each month from October to May, inclusive.

Oklahoma City Academy of Ophthalmology and Otolaryngology

President: Dr. James P. Luton, 117 N. Broadway, Oklahoma City.
Secretary: Dr. Harvey O. Randel, 117 N. Broadway, Oklahoma City.
Place: University Hospital. Time: Second Tuesday of each month from September to May.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. D. D. Stonecypher, Nebraska City, Neb.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m. dinner; 7 p. m. program; third Wednesday of each month from October to May.

Passaic-Bergen Ophthalmological Club

President: Dr. Thomas Sanfacon, 340 Park Ave., Paterson, N. J.
Secretary-Treasurer: Dr. J. Averbach, 435 Clinton Ave., Clinton, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

Philadelphia County Medical Society, Eye Section

President: Dr. Isaac Tassman, 136 S. 16th St., Philadelphia.
Secretary: Dr. Glen Gregory Gibson, 255 S. 17th St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
Secretary: Dr. Robert J. Billings, 509 Liberty Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Reading Eye, Ear, Nose and Throat Society

President: Dr. Isaac B. High, 326 N. 5th St., Reading, Pa.
Secretary: Dr. Paul C. Craig, 232 N. 5th St., Reading Pa.
Place: Wyomissing Club. Time: 6:30 p. m., third Wednesday of each month from September to July.

Richmond Eye, Ear, Nose and Throat Society

President: Dr. Luther C. Brawner, Professional Bldg., Richmond, Va.
Secretary: Dr. Clifford A. Folkes, Professional Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

Rochester Eye, Ear, Nose and Throat Society

President: Dr. Frank Barber, 75 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.

St. Louis Ophthalmic Society

President: Dr. Vincent Jones, 634 N. Grand Blvd., St. Louis.
Secretary: Dr. T. E. Sanders, 508 N. Grand Blvd., St. Louis 3.
Place: Oscar Johnson Institute. Time: Fourth Friday of each month from October to April, inclusive, except December, at 8:00 p. m.

San Antonio Ophthalmo-Oto-Laryngological Society

President: Dr. Belvin Pritchett, 705 E. Houston St., San Antonio 5, Texas.
Secretary-Treasurer: Lt. Col. John L. Matthews, AAF School of Aviation Medicine, Randolph Field, Texas.
Place: San Antonio, Brooke General Hospital, Randolph Field or San Antonio Aviation Cadet Center. Time: 7 p. m., second Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Roy H. Parkinson, 870 Market St., San Francisco.
Secretary: Dr. A. G. Rawlins, 384 Post St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. David C. Swearingen, Slattery Bldg., Shreveport, La.
Secretary-Treasurer: Dr. Kenneth Jones, Medical Arts Bldg., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. Clarence A. Veasey Sr., 421 W. Riverside Ave., Spokane, Wash.
Secretary: Dr. Clarence A. Veasey, 421 W. Riverside Ave., Spokane, Wash.
Place: Spokane Medical Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. A. H. Rubenstein, 713 E. Genesee St., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. H. Blaisdell, 713 E. Genesee St., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

Toledo Eye, Ear, Nose and Throat Society

Chairman: Dr. L. C. Ravin, 316 Michigan St., Toledo 2, Ohio.
Secretary: Dr. W. W. Randolph, 1838 Parkwood Ave., Toledo, Ohio.
Place: Toledo Club. Time: Each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. W. R. F. Luke, 316 Medical Arts Bldg., Toronto, Canada.
Secretary: Dr. W. T. Gratton, 216 Medical Arts Bldg., Toronto, Canada.
Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. Harold M. Downey, 1740 M St. N. W., Washington, D. C.
Secretary-Treasurer: Dr. Richard W. Wilkinson, 1408 L St. N. W., Washington, D. C.
Place: Medical Society of District of Columbia Bldg., 1718 M St. N. W., Washington, D. C. Time: 7:30 p. m., first Monday in November, January, March and May.

Wilkes-Barre Ophthalmological Society

Chairman: Each member in turn.
Secretary: Dr. Samuel T. Buckman, 70 S. Franklin St., Wilkes-Barre, Pa.
Place: Office of chairman. Time: Last Tuesday of each month from October to May.